PB-231 157

A SYNOPTIC SURVEY OF LIMNOLOGICAL CHARACTERISTICS OF THE BIG CYPRESS SWAMP, FLORIDA

John A. Little, et al

Federal Water Quality Administration
Athens, Georgia

May 1970

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 231 157

A SYNOPTIC SURVEY OF LIMNOLOGICAL CHARACTERISTICS OF THE BIG CYPRESS SWAMP, FLORIDA

John A. Little
Robert F. Schneider
Bobby J. Carroll

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Quality Administration
Southeast Region
Southeast Water Laboratory
Technical Services Program

MAY 1970

i.

304

TABLE OF CONTENTS

PAGE

LIST OF TABLES.. iv

LIST OF FIGURES... v

INTRODUCTION.. 1

- Background.. 1
- Objective... 2
- Scope... 3
- Authority... 4
- Acknowledgments... 4

SUMMARY... 6

CONCLUSIONS... 7

RECOMMENDATIONS... 11

STUDY AREA.. 13

- Principal Features.. 13
- Geology and Soils... 16
- Vegetative Features... 17
- Hydrology and Water Quality... 18
- Climate... 19
- Agriculture... 20
- Municipal and Industrial Waste Sources.................................. 22

STUDY METHODS... 24

- Sampling Stations... 24
- Sampling Schedule... 26

ANALYSES AND ANALYTICAL METHODS... 26

- Physical and Chemical Analyses.. 26
- Biological Studies.. 27
- Method of Data Presentation... 30

TABLE OF CONTENTS (Cont'd)

PAGE

STUDY FINDINGS.. 31

Rainfall and Runoff.. 31
Water Quality in the Big Cypress Swamp........................... 32

Habitat Types.. 32
Physical Quality... 37
Chemical Quality... 42
Biological Quality... 57

Detailed Data on Biological Conditions by Station Groups.......... 71

GAC Corporation Canal System...................................... 71
Alligator Alley... 79
Tamiami Trail... 81
Highway 29 and 840A Canals.. 85
L-28 Interceptor Canal.. 88
Upper Okaloacoochee Slough.. 89
Fakahatchee Strand.. 90
Special Biological Study Areas.................................... 92

REFERENCES CITED.. 93

APPENDICES

A. Sampling Stations.. A-1

Part 1 - Sampling Station Site Description........................ A-1
Part 2 - Detailed Description of Biological Stations.............. A-4

B. Biological Study Methods....................................... B-1

C. Analytical Data.. C-1

Part 1 - Physical and Chemical.................................... C-2
Part 2 - Aquatic Biology.. C-31
An Annotated List of Algae.. C-31
An Annotated List of Aquatic Plants............................... C-39
An Annotated List of Terrestrial Plants........................... C-44
An Annotated List of Invertebrates................................ C-48
An Annotated List of Fish... C-59
An Annotated List of Birds.. C-61
Part 3 - Bacterial.. C-75
D. Hourly Variation Studies....................................... D-1

PARTICIPATING STAFF

LIST OF TABLES

TABLE	TITLE	PAGE NO.
I	Municipal and Industrial Waste Sources	23
II	Sampling Station Characteristics	25
III	Physical and Chemical Analyses	28
IV	Secchi Disc Transparency	38
V	Pesticide Analyses and Minimum Detection Limits	51
VI	Summary of Spectrographic Analysis Results	53
VII	Comparative Density of Dominant Rooted Vegetation by Habitat Type	59
VIII	Comparative Density of Dominant Benthos by Habitat Type	61
IX	Geometric Mean Bacterial Densities	64
X	A Comparison of Geometric Mean Total Coliform Levels	66
XI	A Comparison of Geometric Mean Fecal Coliform Levels	67
XII	A Comparison of Geometric Mean Total Plate Counts	69
XIII	Periphyton Population from Selected Stations in the Big Cypress Swamp	72
XIV	A List of Average Dry and Ashed Periphyton Weights from Selected Stations in the Big Cypress Swamp, Florida	74
XV	Phytoplankton Population at Sampling Stations in the Big Cypress Swamp	75
C-I	Summary of Physical and Chemical Analytical Results from Daily Samples	C-2
C-II	Special Inorganic Analyses	C-25
C-III	Spectrographic Analysis Results	C-28
C-IV	Distribution and Abundance of Certain Aquatic Plants in the Big Cypress Swamp, Florida	C-67
C-V	Distribution and Abundance of Benthos in the Big Cypress Swamp, Florida	C-72
D-I	Hourly Variation Study Data	D-1

LIST OF FIGURES

FIGURE NO.	TITLE	FOLLOWS PAGE NO.
1	General Location Map	13
2	Sampling Stations	Rear of report
3	Surficial Flow	18
4	Rainfall for February and March, 1970	31
5	Streamflow at Lower Big Cypress Gaging Stations	31
6	Streamflow in GAC Corporation Canal	31
7	The Mean and Range Values for Water Temperature during March, 1970	38
8	The Mean and Range Values for Turbidity during March, 1970	39
9	The Mean and Range Values for Color during March, 1970	40
10	The Mean and Range Values for Dissolved Oxygen during March, 1970	42
11	The Mean and Range Values for Alkalinity during March, 1970	43
12	The Mean and Range Values for Hardness during March, 1970	43
13	Daily Hardness Values at Selected Stations during March, 1970	43
14	Daily Sulfate Values at Selected Stations during March, 1970	45
15	Range of Chloride Values during March, 1970	45
16	The Mean and Range Values for Organic Nitrogen during March, 1970	46
17	The Mean and Range Values for Ammonia during March, 1970	46
18	The Mean and Range Values for Total Phosphate during March, 1970	46
19	The Mean and Range Values for Iron during March, 1970	48
20	The Mean and Range Values for Total Organic Carbon during March, 1970	49
21	Hourly Quality Variation in GAC Canal System (March 19, 1970)	56
22	Hourly Quality Variation in Fakahatchee Strand (March 24, 1970)	56

LIST OF FIGURES (Cont'd)

FIGURE NO.	TITLE	FOLLOWS PAGE NO.
23	Hourly Quality Variation in Alligator Alley Canal (March 20, 1970)	56
24	Hourly Quality Variation in Tamiami Trail Canal (March 23, 1970)	56
25	Phytoplankton Population during March, 1970	57
26	Periphyton Population during March, 1970	58
27	Average Dry and Ashed Periphyton Weights, March, 1970	58
A-1	Diagrammatic Transect and Sediment Composition at Station 1	A-4
A-2	Diagrammatic Transect and Sediment Composition at Station 4	A-5
A-3	Diagrammatic Transect and Sediment Composition at Station 5	A-5
A-4	Diagrammatic Transect and Sediment Composition at Station 11	A-6
A-5	Diagrammatic Transect and Sediment Composition at Station 14	A-6
A-6	Diagrammatic Transect and Sediment Composition at Station 16	A-7
A-7	Diagrammatic Transect and Sediment Composition at Station 17	A-7
A-8	Diagrammatic Transect and Sediment Composition at Station 18	A-8
A-9	Diagrammatic Transect and Sediment Composition at Station 21	A-9
A-10	Diagrammatic Transect and Sediment Composition at Station 23	A-9
A-11	Diagrammatic Transect and Sediment Composition at Station 27	A-10
A-12	Diagrammatic Transect and Sediment Composition at Station 28	A-11
A-13	Diagrammatic Transect and Sediment Composition at Station 29	A-11
A-14	Diagrammatic Transect and Sediment Composition at Station 32	A-11
A-15	Diagrammatic Transect and Sediment Composition at Station 33	A-12
A-16	Diagrammatic Transect and Sediment Composition at Station 34	A-12
C-1	Daily Total Coliform Concentrations at GAC Canal Stations	C-74
C-2	Daily Total Coliform Concentrations at GAC Canal Stations	C-74

LIST OF FIGURES (Cont'd)

FIGURE NO.	TITLE	FOLLOWS PAGE NO.
C-3	Daily Total Coliform Concentrations at Alligator Alley Stations	C-74
C-4	Daily Total Coliform Concentrations at Tamiami Trail Stations	C-74
C-5	Daily Total Coliform Concentrations at Highway 29 and 840A Canal Stations	C-74
C-6	Daily Total Coliform Concentrations at Upper Okaloacoochee Slough and L-28 Interceptor Canal Stations	C-74
C-7	Daily Total Coliform Concentrations at Fakahatchee Strand Stations	C-74
C-8	Daily Fecal Coliform Concentrations at GAC Canal Stations	C-74
C-9	Daily Fecal Coliform Concentrations at GAC Canal Stations	C-74
C-10	Daily Fecal Coliform Concentrations at Alligator Alley Stations	C-74
C-11	Daily Fecal Coliform Concentrations at Tamiami Trail Stations	C-74
C-12	Daily Fecal Coliform Concentrations at Highway 29 and 840A Canal Stations	C-74
C-13	Daily Fecal Coliform Concentrations at Upper Okaloacoochee Slough and L-28 Interceptor Canal Stations	C-74
C-14	Daily Fecal Coliform Concentrations at Fakahatchee Strand Stations	C-74
C-15	Daily Total Plate Counts at GAC Canal Stations	C-74
C-16	Daily Total Plate Counts at GAC Canal Stations	C-74
C-17	Daily Total Plate Counts at Alligator Alley Stations	C-74
C-18	Daily Total Plate Counts at Tamiami Trail Stations	C-74
C-19	Daily Total Plate Counts at Highway 29 and 840A Canal Stations	C-74
C-20	Daily Total Plate Counts at Upper Okaloacoochee Slough and L-28 Interceptor Canal Stations	C-74
C-21	Daily Total Plate Counts at Fakahatchee Strand Stations	C-74

INTRODUCTION

BACKGROUND

The year 1969 marked a significant event in the history of the development pattern of south Florida. The long term trend of drain, fill, clear, and build in this subtropical area came in for critical review, at least in one area. Approximately 36 miles west of Miami, the Dade/Collier Jetport training facility was nearing completion. The training facility was being constructed on 39 square miles of a wholly undeveloped portion of the Big Cypress Swamp. Eventually, a full-scale commercial airport surrounded by urban development was envisioned. Upwards of 1.5 million people were expected to live in the vicinity. When the full plans for the jetport area became realized, many private, State, and Federal agencies and many individuals interested in protecting the environment made known their opposition. This opposition was directed primarily toward the damage expected to be wrought by the jetport development on the delicate ecology of the Big Cypress Swamp - Everglades system. Many foresaw the end of this ecosystem as we now know it.

The Department of the Interior established a task group in June 1969 to review the situation and make recommendations. The task group report(1) (known popularly as the Leopold Report) was completed in September 1969 under the title "Environmental Impact of the Big Cypress Swamp Jetport." In the report, the unique watershed relationship between the Big Cypress Swamp and the Everglades was described. Details were given of a sensitive ecosystem like no other in the United States or perhaps in the world. Three alternatives for future action at the jetport site were presented. One of these alternatives proposed that a substitute site be found and that the training facilities be transferred to this new location. On January 16, 1970, the Secretaries of the U. S. Departments of Transportation and Interior, the Governor of Florida, the Dade County Port Authority and Collier County entered into a formal agreement to effect transfer of the training facilities. Thus, one of the most significant decisions made to date for protection of a small plot of unique natural habitat was completed.

Unfortunately, the Dade/Collier Jetport isn't the only threat to the Big Cypress Swamp and indirectly to the Everglades. Much of the Swamp is owned by private landholders, from a few acres to the thousands of acres in the hands of the GAC Corporation, Miami, Florida. At present, there is insufficient jurisdictional control on development of these private landholdings. Recognition of the need to effect greater control resulted in a directive from the Secretary of the Interior to certain Interior bureaus on November 19, 1969. This directive recognized the hydrobiologically interdependent relationship between the Big Cypress Swamp and the Everglades National Park. A study, with recommendations by June 1, 1970, was requested to define those portions of the Swamp "which merit special protection."

The Secretary noted that environmental alterations within the Swamp "can seriously affect quality . . . of water." Evaluation of the effect of existing environmental alterations on water quality became one of the reasons for the investigation reported here.

OBJECTIVE

The objectives of the Federal Water Quality Administration's Big Cypress Swamp Study were:

To determine water quality in respective portions of the Big Cypress Swamp;

To evaluate effects of urban, agricultural, and industrial developments on water quality; and

To evaluate the need for maintaining special protection measures in the Big Cypress Swamp and the Everglades National Park.

It was recognized in the establishment of this study that a completely definitive picture of water quality in the Swamp could not be obtained by June 1, 1970. The hydroperiod which is so important to the ecological balance being maintained in the Swamp is subject not only to seasonal variation but also to year-to-year change. Wet cycles occur at approximately ten-year intervals, and it appears that such a wet period is occurring at this time. Water quality extremes in the Swamp vary with the hydroperiod, and thus a completely thorough portrayal of the natural quality variation would require an extended period of study. As this report will show, this does not mean that vital background information on water quality could not be obtained in time for the June 1 deadline.

It was thought that the impact of existing developments could be shown in terms of changes in water quality. This was found to be true. From an analysis of changes in water quality already affected by urban, agricultural and other development, predictions can be made on the effects of additional development.

SCOPE

Within the allotted time frame, it was determined that a one-month field investigation of the Big Cypress Swamp could be conducted. Emphasis would be placed on obtaining the best water quality picture possible for the Swamp and its immediate periphery. This would mean little or no attention given to water quality in the Everglades National Park.

The month of March 1970 was chosen for the field study because historically it has been a dry period of the year. Water quality during a dry period should reflect the maximum values of natural dissolved constituents (e.g. nutrients, metals, and sulfates) present in the Swamp waters. Any increase over the maximum levels observed could be interpreted as man's contaminative influence, an influence which might be reflected in accelerated eutrophication of the waters of the Big Cypress Swamp and Everglades National Park. Man's addition of toxic contaminants can also change the biotic character of the Swamp.

Field studies were conducted in March as scheduled. Sampling stations were located throughout the Swamp, and day-to-day variations in physical, biological, (including bacterial), and chemical character of the waters flowing into, through, and discharging from the study area were recorded.

AUTHORITY

The Federal Water Quality Administration (FWQA) study of the Big Cypress Swamp in southern Florida was performed at the request of the Commissioner, Federal Water Quality Administration (February 6, 1970). Authority for performing water quality investigations of the kind and extent reported here may be found in Section 5 (a) of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.).

ACKNOWLEDGMENTS

Throughout the conduct of field studies headquartered at Naples, Florida, numerous agencies and individuals provided valuable assistance. The courtesies, information, services, and other forms of assistance provided are gratefully acknowledged and thanks extended to the following:

City of Naples Public Works Department (Mr. W. F. Savidge, Director) - for providing fixed laboratory space and parking space for mobile laboratories, for assisting in utility installation, for providing telephone communication, and for various other services.

4a

Tamiami Trail and Canal

Dense periphyton growth in Tamiami Canal

Collier County Engineering Department (Mr. Harmon Turner, County Engineer) - for maps and detailed topographical information on the Big Cypress Swamp (special thanks to Mr. Herb Fries).

Collier County Agent (Mr. Donald W. Lander) - for soil maps and information on agricultural areas and practices.

National Audubon Society, Corkscrew Marsh Sanctuary (Mr. Phillip Owens, Superintendent; Mr. Frank Ligas, Staff Biologist; and Dr. Alexander Sprunt, Jr.) - for valuable information on fish, wildlife, and aquatic biota typical of the various habitats found in the Swamp and the Everglades.

Geological Survey, U. S. Department of the Interior, Miami Office (Mr. Thomas Buchanan, Subdistrict Chief) - for genuine cooperation with a sister agency.

National Field Investigations Center, Federal Water Quality Administration, Cincinnati, Ohio (Mr. A. D. Sidio, Director) - for providing a second mobile laboratory, field personnel, and certain analytical services at Cincinnati.

Analytical Quality Control Laboratory, Federal Water Quality Administration, Cincinnati, Ohio (Mr. Dwight Ballinger, Chief) - for providing spectrographic analyses on composite samples.

Kenneth M. Mackenthun, Chief, Technical Studies Branch, Division of Technical Support, Federal Water Quality Administration, Washington, D. C. - for providing helpful suggestions and detailed review of the study report.

SUMMARY

A one-month synoptic study of the limnological characteristics of the Big Cypress Swamp, Florida, was conducted in March 1970. This study was undertaken by the Federal Water Quality Administration to insure that as much information as possible would be available on water quality to serve as background for this agency's participation in a larger effort by U. S. Department of Interior agencies to develop recommendations on the need to maintain special protection areas in the Swamp.

Thirty-four sampling stations were established throughout the Big Cypress. These stations were chosen to be representative of the many different aquatic habitats in the Swamp. The waters were examined for physical, chemical, and biological characteristics. Special attention was directed to evaluation of the water quality impact of typical urban, agricultural, and other development in the study area.

A large amount of limnological information was collected during the study, especially on the biological character of the Big Cypress Swamp. For a general discussion of the findings, the reader is referred to the section WATER QUALITY IN THE BIG CYPRESS SWAMP. Conclusions and recommendations resulting from this study follow.

CONCLUSIONS

The Big Cypress Swamp is a complex aquatic environment that supports a subtropical biota unique to the United States. Unless immediate protective steps are taken, man's alteration through drainage and/or clearing of selected areas will destroy this ecosystem and detrimentally affect the Everglades National Park. Piecemeal development -- residential, agricultural, industrial, and commercial -- has already resulted in unbalanced biological development deleterious to the present Swamp ecology, deteriorated water quality, a decrease in the water environment essential to many animal species, increased water temperature, and increased concentrations of certain elements potentially toxic to aquatic life.

1. A shift is taking place in the aquatic habitat from the natural ecosystem of wet prairies, marshes, and sloughs to a canal ecosystem. Many of the canals are subtly showing an unbalanced biological development of massive water lettuce and water hyacinth beds and rough fish dominance.
2. Drainage of portions of the Big Cypress Swamp will reduce or eliminate the hydroperiod in wet prairies and marshes. This will reduce the feeding and spawning grounds for fauna. Many native animals are already among the rare and endangered species of reptiles, birds, and mammals. Ultimately, the result of drainage is migration or extinction of those animal, and plant, species dependent on an established hydroperiod. Urban development along canals will likewise reduce or eliminate certain dependent wildlife.
3. Drainage of marshes and wet prairies leave these areas susceptible to disastrous peat fires. Even without fires, compaction and oxidation of the limited peat and other organic soil deposits is a consequence of drainage.

4. The GAC Corporation canals and those alongside Florida Highways 29 and 840A divert water away from the Swamp and directly to the sea. This drastically alters the historical sheet flow pattern entering the Everglades National Park and changes the water quality that formerly entered estuarine areas. Saltwater encroachment along most of the Ten Thousand Islands area will increase as the freshwater overland flow is reduced in volume.
5. Drainage canals are being used intentionally and unintentionally to transport wastes away from residential, commercial, industrial, and agricultural areas. With increased development in the Big Cypress, the quality of water in the canals will deteriorate.
6. Many canal systems are developed coincidentally by highway construction. Runoff from the highways enters the canals. Road accesses to these water transport systems permit clandestine disposal of solid wastes. Poor water quality can be extended many miles downstream from canal areas where runoff enters or waste is dumped.
7. Most canals in the Swamp are subjected to weed control and/or sediment removal. Resulting introduction of herbicides, dead organic matter, and suspended sediments causes water quality damage.
8. The canal from the GAC Corporation development which discharges into Fahka Union Bay brings iron, lead, and aluminum into these estuarine waters in concentrations and amounts greater than existed under natural undrained conditions. Also, the iron and lead levels found would be damaging to water supply use should such use be made of these canal waters.
9. Light penetration and turbidity data show that the canals in the newly developing GAC Corporation area transported pollutional levels of sediment into coastal areas not previously subjected to such water quality problems.

10. Water temperatures were 2°C cooler in March 1970, in the shaded cypress strand areas, (e.g. Fakahatchee Strand), than in the canals more exposed to sunlight. The increased water temperatures and sunlight exposure resulting from clearing and drainage operations will change the aquatic ecology and stimulate growths of undesirable plant species such as blue-green algae.

11. Total phosphorus levels, which averaged less than 0.1 mg/l at all stations, were one indication of relatively low nutrient enrichment in the waters of the Big Cypress during March. The highest individual total P concentration (0.38 mg/l) was observed in the vicinity of a heavy bird population at Station 29. Total organic nitrogen and total organic carbon analyses revealed no significant information on man's influence on the Big Cypress. Low nutrient levels in the Swamp waters were the result of either assimilation of nutrients by the profuse biota or accumulation in the sediments.

12. The hourly observations of changes in dissolved oxygen, CO_2, pH, and temperature at stations in the GAC canal system, along Alligator Alley, along Tamiami Trail, and in the Fakahatchee Strand show that photosynthetic and bacterial activity was highest in the two latter areas. This would be expected for older canal areas and for sloughs where the aquatic biota were more abundant.

13. Hardness, alkalinity and sulfate data reveal a significant difference in quality between water in the GAC canal system and the remainder of the Swamp. Seepage of groundwater into the canals (which represents diminishment of an important water resource) accounts for the higher concentrations of hardness, alkalinity, and sulfate in the GAC system.

14. Although no oil contamination was evident in March and the oil field operation was a clean one, a potential oil pollution hazard exists near Sunniland,

Florida. The limestone mining operation near Sunniland causes localized pollution from dust spreading over nearby water areas (Okaloacoochee Slough) and from stormwater runoff over exposed spoil disposal areas.

15. A comparison of phytoplankton and periphyton populations indicated that the latter is the major source of aquatic primary production.
16. Presently, there are no bacterial problems of significance in the study area. If development continues, bacterial and viral problems could result from increased urban runoff, improperly treated domestic wastes (e.g. septic tanks), and runoff from lands with increased cattle populations.

RECOMMENDATIONS

If the limnological character of the Big Cypress Swamp and the hydrobiologically dependent Everglades National Park ecosystem is to be preserved, then the following recommendations should be met:

1. The construction of canal(s) in the Fakahatchee Strand should be halted immediately. Those canal(s) which now intercept and divert water from the Strand should be blocked or filled to prevent further artificial drainage of this important slough.
2. Additional drainage of the Big Cypress Swamp, including that associated with road construction and commercial, residential, agricultural, and industrial development, should be prevented.
3. The feasibility of reintroducing water into the Big Cypress from the Highway 29 (Barron River) and 840A (Turner River) canals should be investigated. Some restoration of sheet flow patterns and natural hydroperiod could be effected in this manner.
4. The existing spoil areas and exposed banks alongside recently constructed canals should be sprigged or seeded in order to reduce erosion problems.
5. Although defining the limits for all areas which merit special protection was considered beyond the scope of this study, the Fakahatchee Strand must be included as a protected area because it is the major slough in the western section of the Big Cypress Swamp. Unimpeded flow from the Strand is vital to continued existence of portions of the Everglades National Park.
6. Special attention must be given to future waste treatment facilities in the developed and developing urban areas. Advanced levels of waste treatment, including nutrient removal and effluent chlorination, must be achieved

for all domestic wastes entering the Big Cypress-Everglades system. In order to protect both ground and surface waters, the use of septic tanks for waste treatment in these areas must not be permitted. Treatment comparable to that for domestic wastes should be instituted for all other point source wastes.

7. The operating oil wells and exposed pipe areas in the Sunniland oil field (Humble Oil Company) should be diked or walled off in order to contain any accidental spillage.
8. The method and extent of the limestone mining operations near Sunniland should be regulated. Dust and erosion control measures must be adopted in order to prevent damage to water quality in the adjacent Swamp waters (including Okaloacoochee Slough).
9. A limnological monitoring program should be initiated in the developed and developing areas, e.g. GAC Corporation lands and in the vicinity of Immokalee. A separate study should also be made in the Ten Thousand Islands area (especially Fahka Union Bay) to evaluate the effect of altered flow patterns brought on by canal construction. Any damages detected by either the monitoring program or the special study should be remedied.

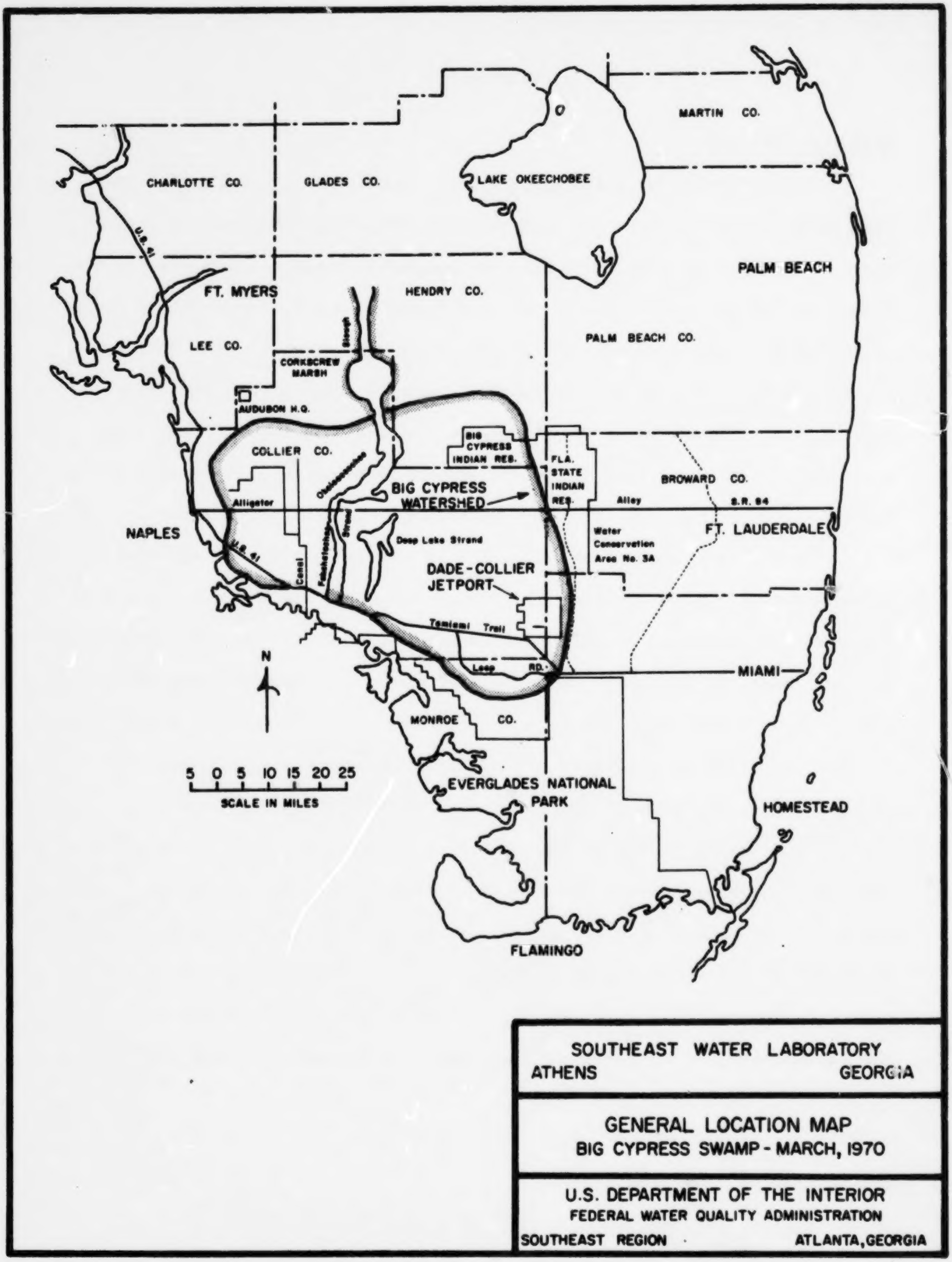
STUDY AREA

PRINCIPAL FEATURES

The area chosen for water quality investigation was generally that considered historically as the Big Cypress Swamp watershed. This general area is shown in relation to other south Florida topographic features in Figure 1. The Swamp includes over 1200 square miles of the coastal lowlands of southern peninsular Florida. The vast majority of Swamp acreage is located within Collier County. In fact, most of Collier County is or once was a part of the Big Cypress Swamp. Encroachment of agricultural interests on the north and large-scale residential development along the western Swamp border have reduced the total coverage of what can be called the Big Cypress Swamp today.

Figure 2 (rear of report) delineates in greater detail the study area as it exists at this time. From the GAC Corporation canal system (over two-thirds complete) westward, much of the wetland area of this part of the Swamp boundary is being drained. Eventually, succession of dry-land vegetative forms will occur. Water quality will change also. The very size, over 100,000 acres, of the GAC land development program in Collier County suggests significant effect on the ecology of a large part of what once was the Big Cypress Swamp. One brochure describing the GAC Golden Gate development states that ponds and glade land scattered through the properties may contain surface water prior to drainage. The 2500-acre section of Golden Gate on which housing has been and is now being constructed was first drained and then cleared of practically all vegetation before construction began. The GAC Corporation properties extend north and south from Corckscrew Marsh to near Collier-Seminole State Park.

FIGURE 1


MARTIN CO.
CHARLOTTE CO.
GLADES CO.
LAKE OKEECHOBEE
U.S. 41
PALM BEACH
FT. MYERS
HENDRY CO.
Slough
LEE CO.
PALM BEACH CO.
CORKSCREW MARSH
AUDUBON H.Q.
BIG CYPRESS INDIAN RES.
COLLIER CO.
Okaloacoochee
FLA. STATE INDIAN RES.
BROWARD CO.
BIG CYPRESS WATERSHED
Alligator
Alley
S.R. 84
NAPLES
Fakahatchee
Strand
Deep Lake Strand
Water Conservation Area No. 3A
FT. LAUDERDALE
U.S. 41
Canal
DADE-COLLIER JETPORT
Tamiami Trail
Loop RD.
MIAMI
N
MONROE CO.
5 0 5 10 15 20 25
SCALE IN MILES
EVERGLADES NATIONAL PARK
HOMESTEAD
FLAMINGO

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

GENERAL LOCATION MAP
BIG CYPRESS SWAMP - MARCH, 1970

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER QUALITY ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

3b

Clearing for residential development

The Seminole Indian (Big Cypress) Reservation is located in the northeast corner of the Swamp and the Dade/Collier jetport in the southeast corner. Only the southern third of the roughly rectangular, 39-square-mile jetport site has been disturbed by construction. In addition to the 10,500-foot training runway, a small control tower, and a limited amount of flight control equipment, the developed part of the jetport shows cleared areas alongside the runway and access roads, five large borrow pits, an extensive taxi strip system, and construction equipment and office areas. The disturbed ecology is apparent.

Most of the eastern boundary of the Swamp is bordered by levees of Water Conservation Area No. 3A. The entire water conservation system was constructed by the Corps of Engineers and is maintained by the Central and Southern Florida Flood Control District. Two interceptor canals for this Conservation Area, L-28 and L-28 tieback, extend into eastern portions of the Swamp and affect the natural surface water runoff and drainage.

The least disturbed sections of the Big Cypress Swamp, and consequently those most amenable to preservation and control, are as follows:

A. Fakahatchee Strand - natural drainage here is already affected detrimentally by the GAC Corporation canal system.

B. Okaloacoochee Slough - some cattle land and farming in northern portion.

C. All parts of Swamp east of Highway 29 and south of Alligator Alley - largest undisturbed section of Swamp, but now contains jetport site.

D. Section of Swamp north of Alligator Alley, east of Highway 840A, and south of Hendry County Line - wholly undisturbed except for small hunting and fishing camps, and the L-28 interceptor canal.

The principal topographical feature along the southern border of the Swamp is the Tamiami Trail (U. S. 41) and Canal. A new east-west toll road, Florida Highway 84 (also known as Alligator Alley), bisects the Swamp. This highway relieves traffic moving between Florida's lower east and west coasts. A small number of vehicular service areas have been built along the Tamiami Trail, but no development of any type is permitted on Alligator Alley. Along the northern Swamp limits, Florida Highway 846 passes through Collier County in a general east-west direction. State Roads 29 and 840A are the principal north-south highways within the Big Cypress Swamp. Highway 29 connects the municipalities of Immokalee and Everglades City, while 840A is an improved gravel road joining Alligator Alley and the Tamiami Trail. Associated with and resulting from construction of most of these roads is a canal paralleling the roadway. These canals have altered historical sheet flow patterns throughout the Swamp.

There are no municipalities now located entirely within the Swamp boundaries. The municipalities of Naples (county seat), Everglades City, and Immokalee are all situated along the periphery. (A portion of Immokalee is included in the Swamp watershed.) Immokalee is the commercial center of the largest farming area in Collier County. Truck farms, cattle ranches, and some citrus groves are located nearby.

At the community of Sunniland, Florida, along Highway 29, the Humble Oil Company has a small oil well field. Approximately ten derricks are located in the vicinity, and about one-half of the wells are operating. Also nearby is a limestone quarry, which is situated immediately adjacent to the Okaloacoochee Slough, one of the most important drainage systems in the Swamp.

Large areas of Swamp in southern Hendry County outside the Seminole Reservation have remained relatively unaffected by man. These too could be included as protected areas of the Big Cypress Swamp.

The Corkscrew Marsh adjacent to the northwest corner of the Swamp is considered separate from the Swamp but is hydraulically connected during high water.

In addition to the conservation pool along the eastern border, the physiographic regions which border the Big Cypress Swamp are: Pine Flatland on the north and northwest, Southwest Coast and Ten Thousand Islands on the southwest, and Everglades on the south.(2)

GEOLOGY AND SOILS

The principal geological feature of the Big Cypress Swamp area is the presence of the Tamiami limestone formation which generally lies a few feet below the soil surface but is exposed in some locations.(2) Most of the soils which cover the limestone have a relatively low natural fertility and are basically composed of fine sand. Some marl is also present. Areas of densest rooted vegetation give rise to muck and peat deposits. The thickness of the peat deposits and extent of their coverage, coupled with a different underlying limestone formation, accounts for the basic geological difference between the Big Cypress Swamp and the Everglades.(1) The latter has thicker, more extensive areas of muck and peat deposit overlying Miami Oolite limestone. Phosphatic material has been reported in the marl deposits of the Okaloacoochee Slough.(2)

Surface water quality is closely related to the geology of the Swamp since the exceptionally long hydroperiod permits equally long exposure to the surface and near-surface soils in the area. Drainage canals which expose

Tamiami limestone also intercept the groundwater which flows through the shallow soil layer. The quality of water in many of these canals reflects the presence of groundwater seepage.

VEGETATIVE FEATURES

The only consistent characteristic of the vegetative cover of the Big Cypress Swamp is its diversity. Thick forests of cypress and mixed hardwoods (strands) in the wet areas where richer soil abounds yield to nearly treeless grass-sedge areas (wet prairies). There are also drier areas of pine, palm, and palmetto in varying mixtures, but the cypress gives the Swamp its name. The abrupt change from cypress predominance to sawgrass marks the boundary between the Big Cypress and the Everglades.

Many of the disturbed areas, especially those adjacent to roads, are characterized by the regrowth association of willow and red maple brush. Most of the trees in the Swamp, and especially the hardwoods, are covered with epiphytes. The many species of these air-plants and of other unusual plants make the Swamp a botanist's dream and provide much of the basic appeal of the area as a refuge from the commonplace.

The unique ecology of the Big Cypress is perhaps best exemplified by the vegetative makeup of the Fakahatchee Strand. A mixed stand of royal palm and bald cypress is probably the only one of its kind in the world.

Wildlife abounds in all wilderness sections of the Swamp. The many migratory or resident waterfowl which frequent the area dominate wildlife forms in the cypress strands and affect water quality throughout the Swamp.

HYDROLOGY AND WATER QUALITY

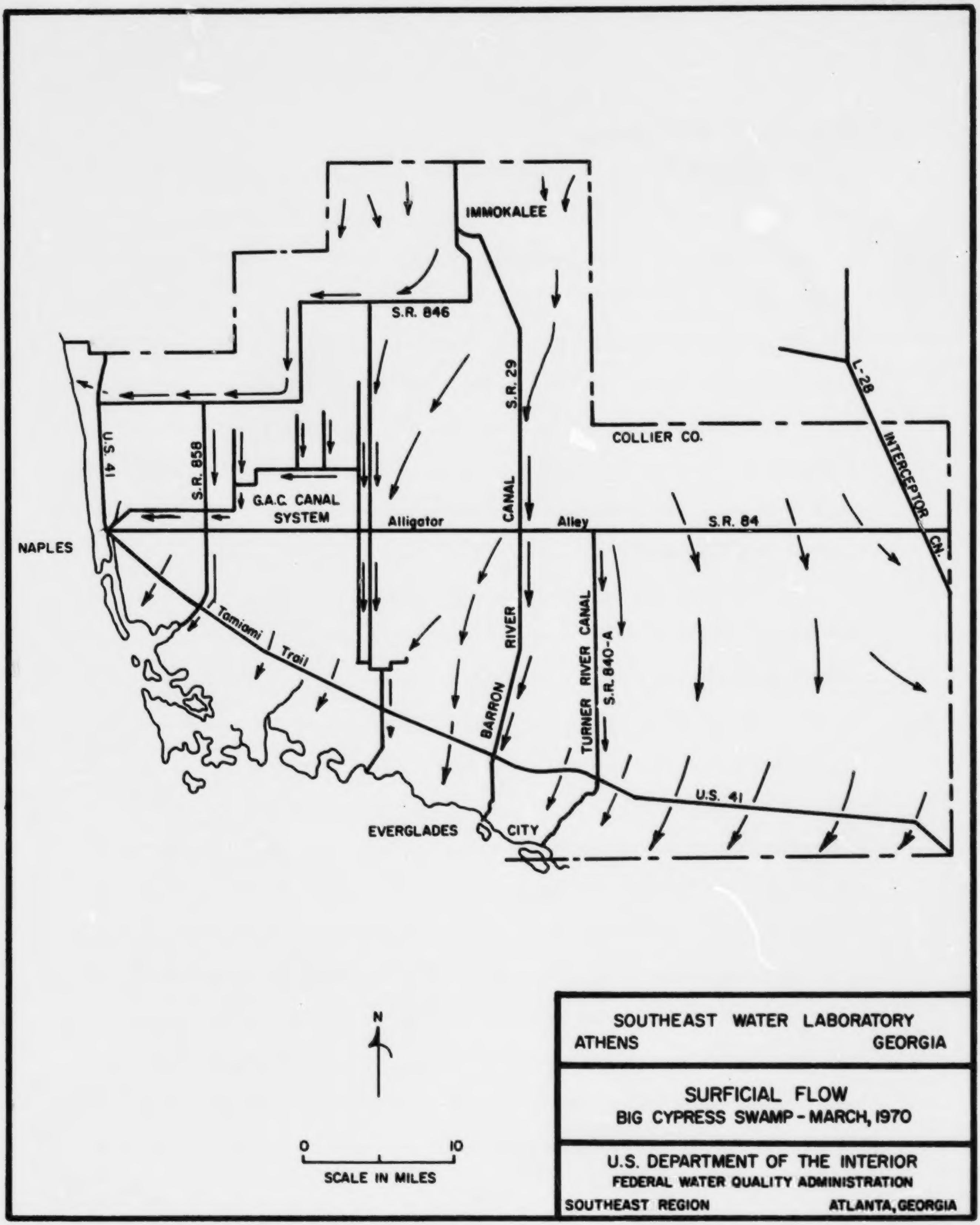
The sluggish, overland sheet flow which dominates the runoff pattern of south Florida is easily diverted by channelization. Consequently, man has both consciously and unintentionally affected historical runoff characteristics through canal construction. Although interconnected sloughs remain an important means of transporting surface waters from one part of the study area to another, the GAC canals and the canals which parallel Highways 846, 29, and 840A all influence surficial flow (Figure 3). The canals alongside Alligator Alley and the Tamiami Trail serve only to collect the predominantly north-to-south flow and distribute the water to the nearest outlets spaced at intervals beneath these highways.

One effect of the existing drainage canals is to reduce the length of the hydroperiod so vital to the preservation of the Swamp ecology. Any reduction in hydroperiod would change the quality of water fed into the Everglades National Park from the Big Cypress Swamp. Interception of groundwater by the construction of canals can and does change water quality also.

The average annual flow from the Big Cypress watershed upon which the very existence of the Everglades National Park depends was estimated in the Leopold Report(1) as approximately 350,000 acre-feet. This flow constitutes over 50 percent of the total flow entering Everglades National Park. Any deterioration of significant change in the quality of water discharged from the Big Cypress watershed would detrimentally affect the ecology of the Park.

Groundwater in Collier County serves as the primary source of water for municipal and agricultural use. According to the 1962 Geological Survey report(3) on Collier County's groundwater resources, an extensive, shallow

FIGURE 3


IMMOKALEE
S.R. 846
S.R. 29
U.S. 41
S.R. 858
G.A.C. CANAL SYSTEM
COLLIER CO.
L-28
INTERCEPTOR CN.
NAPLES
Alligator
CANAL
Alley
S.R. 84
Tamiami
Trail
BARRON
RIVER
TURNER RIVER CANAL
S.R. 840-A
U.S. 41
EVERGLADES
CITY
N
0
10
SCALE IN MILES

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SURFICIAL FLOW
BIG CYPRESS SWAMP - MARCH, 1970

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER QUALITY ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA

aquifer is the chief groundwater source. This aquifer yields 1000 gpm and greater and ranges in depth from the surface to 130 feet. It is recharged by local rainfall, including that falling on the Big Cypress. The Floridan Aquifer which lies at much greater depths has also been tapped but is generally of poorer mineral quality. Considerable leakage from wells bored into the Floridan Aquifer have affected surface water quality in some areas. Over 50 flowing wells were noted in the Geological Survey report but most of these (40 percent near Immokalee) are outside the Big Cypress Swamp watershed.

Water quality in both the shallow and Floridan aquifers varies appreciably throughout the county, but one aquifer can usually be distinguished from the other. Total dissolved solids (TDS) in Floridan Aquifer water ranges between 800 and 6,000 mg/l, while the TDS range for the more heavily used shallow aquifer is a lower 200 to 1,000 mg/l.(3) Chlorides may exceed 1,000 mg/l in both aquifers and iron varies considerably (as low as 0.01 and high as 2.3 mg/l). The sulfate content can be used to distinguish one groundwater source from the other; 100 to 500 mg/l for the Floridan Aquifer and usually 0 to 20 mg/l in the shallow aquifer. This discussion of groundwater quality is included here because of the interrelationship between ground and surface water quality in areas of flowing wells and/or canal construction. More on this point may be found in later sections.

CLIMATE

The subtropical climate in the Big Cypress Swamp area is directly responsible for many of the Swamp's features. It is warm enough to permit year-round growth of many forms of plant life and wet enough (about 57 inches annual rainfall) to replenish the areas of standing water during the rainy season. Most of the annual rainfall occurs between the months of May through October. Normally, rainfall over the Swamp averages about 1.5 inches in January, 1.5 to 2 inches in February, and less than 3 inches in March. Biological activity is stimulated by the year-round warm temperatures and the wet environment. Heavy rainfall which is common can quickly change the quality of water moving from one Swamp area to another.

AGRICULTURE

Runoff from agricultural areas can add nutrients such as nitrogen and phosphorus, suspended organic and inorganic matter, and pesticides to receiving water bodies. Where fertilizers and pesticides are applied from spray planes, watercourses surrounding cultivated land can receive these water contaminants directly. As stated previously, the area surrounding Immokalee, Florida, is the primary agricultural zone in the Big Cypress study area. The permeability and flatness of the land around Immokalee is not conducive to appreciable surface runoff during rainy periods but aerial spraying is significant.

According to the Collier County Agricultural Agent,(4) approximately 28,000 acres (not all in the Big Cypress watershed) were cultivated in Collier County in 1968-69 for truck crops such as tomatoes, melons, corn, squash, and cucumbers. Another 6,500 acres of citrus groves existed during the same period. In the Immokalee agricultural area, including the southern portion of Hendry County, approximately 36,000 cattle graze the scattered pasture areas. Many of these grazing areas are located immediately adjacent to the Okaloacoochee Slough.

The lack of natural fertility in the soil coupled with insect and/or weed growth problems requires farmers in Collier County to apply fertilizers, pesticides, and herbicides heavily. The type and amount of each application varies with the season and the type crop. For example, citrus crops may require a postbloom spray in March or April, plus summer spray, fall spray, dormant spray, and sprays between seasons. The Collier County Agent lists(4) the following proprietary types of sprays for crops in the Big Cypress area:

Pesticides for citrus -	Ferbam
	Kelthane
	Parathion
	Systox
Pesticides for vegetables - (tomatoes and watermelon)	Sevin
	Systox
	Cygon
	Phosdrin
	Thimet
Fungicides -	Maneb
	Copper-base products
	Dithane M-45
	Dyrene

Most of the pesticides, with the exception of Kelthane, are the less persistent phosphorylated types.(5) Some herbicide application for control of water hyacinths in the canals of Collier County is usually initiated during late March or early April.

During the March 1970 field study period, citrus crops, squash, tomatoes, and certain other vegetables were being harvested.

MUNICIPAL AND INDUSTRIAL WASTE SOURCES

The Big Cypress Swamp is unique in many ways. At least for the present time, it is unique for its limited number of municipal (sanitary) or industrial waste problems. Table I lists and evaluates those waste sources which do affect the Big Cypress.

TABLE I

MUNICIPAL AND INDUSTRIAL WASTE SOURCES

Source	Remarks
Municipal Waste; Immokalee, Florida	No sanitary sewerage system; septic tanks.
Urban runoff; Immokalee, Florida	Some runoff reaches Highway 29 canal, most enters Corkscrew Marsh drainage system.
Humble Oil Company well field, Sunniland, Florida	No active drilling at present time. Half dozen pumping wells have clean operation but represent an ever-present oil pollution hazard.
Limestone mining, Sunniland, Florida	Dust from trucking operations settles throughout vicinity, and entire mining operation is detrimental to water quality of nearby Okaloacoochee Slough.
GAC Corporation Residential Areas	Golden Gate Subdivision has sewerage system with activated sludge treatment plant discharging effluent outside Big Cypress study area. A small package aeration plant serves a trailer and motel area at the Remuda Ranch Development on the Tamiami Trail. No problem now but could become one as the area develops.

STUDY METHODS

SAMPLING STATIONS

The number and location of sampling stations and the sampling frequency were selected to be representative of spatial and temporal quality variations throughout the study area. The stations were chosen to be representative of the following types of aquatic habitats in the Big Cypress Swamp:

A. Cypress swamp

B. Canal - several types reflecting varying degrees of swamp development, e.g. those draining cleared residential areas and those adjacent to roads.

C. Slough - the natural drainage system in the swamp.

D. Wet prairie

E. Pond

F. Hardwood hammock

G. Sawgrass marsh

A second consideration in sampling site selection was to determine any changes in water quality within a distinct drainage system. An example here would be selecting upstream and downstream sampling sites in the Okaloacoochee Slough and in the GAC canal system.

Thirty sampling stations were selected following a final reconnaissance during the first week in March. The first samples were collected on March 4, 1970. Before the end of the month, four more stations were added and limited sampling conducted at these sites. A detailed description of sampling station locations is contained in Appendix A. The representative characteristics of each station are summarized in Table II. Figure 2 (rear of report) shows the location of each station within the study area.

Oil waste pit, Sunniland, Florida

24 b

Sewage treatment plant at Golden Gate subdivision

TABLE II

SAMPLING STATION CHARACTERISTICS

Station Number	Representative Characteristic
1	GAC canal system downstream from residences and sewage treatment plant.
2	GAC canal in uncleared area.
3	GAC canal in uncleared area.
4	GAC canal in uncleared area near agricultural zone.
5	Canal draining from jetport area and undeveloped swamp area.
6	GAC canal reflecting changes in water quality from upstream site.
7	Recently constructed GAC canal downstream from bridge construction.
8	Fakahatchee cypress strand on Alligator Alley.
9	Highway 29 canal in Okaloacoochee Slough area.
10	Highway 29 canal at juncture with Okaloacoochee Slough, downstream from Sunniland, Florida.
11	Okaloacoochee Slough in wet prairie area upstream from Sunniland, Florida.
12	Cypress swamp at Alligator Alley, near Okaloacoochee Slough.
13	Alligator Alley downstream from open land area.
14	Stream gage site on Alligator Alley at cypress strand.
15	Major flow-through drainage site on Alligator Alley.
16	L-28 Interceptor Canal draining from undeveloped swamp area and Indian Reservation.
17	Highway 840 A canal in Deep Lake Strand area.
18	A downstream point in GAC canal system.
19	Partially completed GAC canal downstream from active dredging site.
20	Undisturbed section of Fakahatchee Strand.
21	Fakahatchee Strand sampling site nearest to GAC canals.
22	Undisturbed section of Fakahatchee Strand at stream gage.
23	Major GAC collector canal draining into Faka Union Bay.
24	Downstream point in Highway 29 canal.
25	Tamiami Trail adjacent to large wet prairie area.
26	Downstream point in Highway 840 A canal, riffle area nearby.
27	Junction of Highway 840 A canal and Tamiami canal at stream gage.
28	Tamiami Trail at Turner River Slough.
29	Tamiami Trail at major flow-through drainage site.
30	Tamiami Trail at major flow-through drainage site.
31	Upstream point in Okaloacoochee Slough.
32	Cypress pond in Fakahatchee Strand.
33	Wet prairie in Fakahatchee Strand.
34	Sawgrass marsh.

Most sampling sites on Alligator Alley and the Tamiami Trail were located at bridge crossings. Water quality at these points was affected only to a minor extent by the vehicular traffic along the roadway. This is to say that the quality of water at these bridge sampling sites was primarily representative of the nearby swamp area. Biological study sites at stations along the Alley and the Trail were located near the bridges in relatively undisturbed areas.

SAMPLING SCHEDULE

An alternating schedule was established with approximately half of the total number of stations sampled each day. After collection, the samples were transported to the two mobile laboratories located at Naples, Florida, and then subjected to routine chemical, physical and bacteriological examination. The difference in time between sample collection and analysis was usually less than five hours. Sampling throughout March on a five-day week schedule permitted a total of eight samples to be obtained for most stations.

Biological studies were conducted on a one-time basis at selected stations. Samples for pesticide and organic scan analyses were obtained on a grab basis, once for each station during the month. Samples for spectrographic analysis were composited over a two-week period for all stations.

A staggered system for sample collection time at any one station was utilized in order to account for quality variations which occur during the day (for such parameters as dissolved oxygen, temperature and pH). Certain stations were selected for special study of hourly quality changes.

ANALYSES AND ANALYTICAL METHODS

PHYSICAL AND CHEMICAL ANALYSES

For determination of physical and chemical water quality characteristics, some analyses and/or measurements were made at the sampling sites, some were made within a few hours of collection at mobile laboratories in Naples, Florida, and some were made at FWQA laboratories[1] in Athens, Georgia and Cincinnati, Ohio. Table III lists the physical and chemical analyses, the frequency of analysis, and where the analysis or measurement was performed.

Flow measurements made by the Geological Survey were obtained for the months of February and March. Rainfall data were also obtained from recording stations in or near the study area.

BIOLOGICAL STUDIES

Appendix B contains a detailed description of the biological techniques employed in this study. Time limitations did not permit determination of seasonal biotic succession. However, an extremely informative assemblage of data was collected on the aquatic biology at 33 of the 34 stations. Moreover, the information obtained on aquatic biology was supplemented and complemented by qualitative data on birdlife and terrestrial plants in the sampling station area.

Biological study stations did not always coincide exactly with water sampling sites but were always located nearby (water quality differences were insignificant). By moving the biological station slightly, a stratified sampling technique could be employed. Plankton and periphyton samples were collected at regular water sampling points.

In general, the following information was obtained for biological stations in the study area:

---

[1] Southeast Water Laboratory, Athens, Georgia. National Field Investigation Center, Cincinnati, Ohio. Analytical Quality Control Laboratory, Cincinnati, Ohio.

TABLE III

PHYSICAL AND CHEMICAL ANALYSES

PARAMETER	FREQUENCY OF MEASUREMENT	WHERE DETERMINED
Physical		
Temperature	Daily	Field
pH	Daily	Field and mobile lab
Turbidity	Daily	Mobile lab
Color	Daily	Mobile lab
Conductivity	Daily	Mobile lab
Light penetration	Once per station	
Chemical		
Total dissolved solids	Selected grab samples	Athens, Georgia
Dissolved oxygen	Daily	Mobile lab
Total organic carbon	Daily	Cincinnati, Ohio
Inorganic carbon	Daily	Cincinnati, Ohio
Alkalinity	Daily	Mobile lab
Hardness	Daily	Mobile lab
CO_2	Special diurnal study only	Field
Total and dissolved phosphorus	Daily	Cincinnati, Ohio
Organic nitrogen	Daily	Cincinnati, Ohio
Ammonia nitrogen	Daily	Cincinnati, Ohio
Nitrate nitrogen	Daily	Cincinnati, Ohio
Sulfate	Daily	Mobile lab
Chloride	Selected grab samples	Athens, Georgia
Copper	Daily	Cincinnati, Ohio
Iron	Daily	Cincinnati, Ohio
Manganese	Daily	Cincinnati, Ohio
Zinc, Nickel, Cadmium, Cobalt, Arsenic, Lead, Boron, Chromium, Phosphorus, Vanadium, Iron, Barium, Molybdenum, Strontium, Manganese, Beryllium, Aluminum, Copper, Silver	Spectrographic analysis of one sample composited for each station over a two-week period.	Analytical Quality Control Laboratory, Cincinnati, Ohio
Organochlorine and organophosphate pesticides	One grab sample per station	Athens, Georgia
General organic : gas chromatograph and infrared scan	One grab sample per station	Athens, Georgia

Note: Daily frequency is for a five-day week and for approximately one-half of the stations on any one day.

A. Photographs showing emergent and terrestrial plants.

B. Description of surrounding land area.

C. Morphometry and substrate composition.

D. Euphotic zone.

E. Qualitative inventory of fish, birds, and terrestrial plants in the immediate area.

F. Location, extent and depth of aquatic vegetation.

G. Type and relative density of aquatic plants.

H. Quantitative growth of periphyton (using artificial substrates).

I. Quantitative and qualitative plankton data.

J. Invertebrates associated with aquatic plants.

K. Quantitative and qualitative benthos data.

With the exception of items H and I, the biological information was obtained at approximately half of the 33 stations, this half chosen as most representative of the several habitat types. Periphyton growth measurements were made at 30 stations and plankton determinations at all 33.

The total amount of biological information obtained represents what is believed to be the most exhaustive compilation of its kind for the Big Cypress Swamp area. This is also true of the physical, chemical and bacteriological data. All of the data can be used to provide insight into existing conditions as well as to provide background knowledge to evaluate future ecological changes.

Bacteriological studies consisted of total coliform and fecal coliform examination and total plate counts. Samples were collected daily.

METHOD OF DATA PRESENTATION

The following sections of the report are devoted to presentation and discussion of the March 1970 study findings. These findings are presented first in a general discussion of water quality throughout the study area. This is followed by more detailed discussion of biological quality by selected groupings of stations, the groupings chosen to represent areas with similar characteristics. Station groupings are as follows:

A. GAC Corporation canal system: Stations 1,2,3,4,6,7,18,19 and 23.

B. Highway 29 (Barron River) and 840A (Turner River) canals: Stations 9,10,24,17,26,27.

C. Upper Okaloacoochee Slough: Stations 11 and 31.

D. Tamiami Trail (U. S. 41): Stations 5,25,28,29 and 30.

E. Alligator Alley (Florida Highway 84): Stations 8,12,13,14 and 15.

F. L-28 Interceptor Canal: Station 16.

G. Fakahatchee Strand (Janes Scenic Drive): Stations 20,21 and 22.

H. Special Study Areas: Stations 32 (cypress pond), 33 (wet prairie, and 34 (sawgrass marsh).

STUDY FINDINGS

RAINFALL AND RUNOFF

The Leopold Report(1) indicated that water levels in the Big Cypress normally decline between January and May of each year. Water levels in March are usually about two-thirds of the annual average. The reason for the decreasing amounts of standing water at the beginning of each year is the low amount of rainfall occurring during this period. Rainfall over the Big Cypress area normally averages about two inches in February and slightly less than three inches in March.

In 1970, water levels were unusually high at the beginning of the year but proceeded to fall during January and February. Rainfall in February was near average (Figure 4). Levels continued to fall during the first few days of the March 1970 study, but the pattern was reversed abruptly during the weekend of March 7. At this time a general rainfall (Figure 4) over the Swamp area brought in approximately double the average monthly rainfall, i.e. six inches. More rain fell during the following week, and flooding was reported in the Immokalee area following another four-inch rain during the latter part of March. Over eleven inches total rainfall occurred in the Big Cypress area during the month.

Flows at Geological Survey stream gage sites on the various canals and other drainage systems in the study area were declining but were above average at the beginning of March. Figure 5 shows flows during February and March[1/] for the Tamiami Canal outlets (Forty-Mile Bend to Monroe Station and Monroe Station to Carnestown), and for Fakahatchee Slough at Janes Scenic Drive. Figure 6 shows flows for the same period on the GAC Remuda Ranch Canal (Station 23) and the GAC Golden Gate Canal (Station 1). The heavy rainfall during March was reflected in all the flows shown. In the Tamiami Canal outlets reach from Forty-Mile Bend to

---

[1/] Provided by the Geological Survey, Miami, Florida, office.

FIGURE 4
RAINFALL FOR FEBRUARY & MARCH, 1970

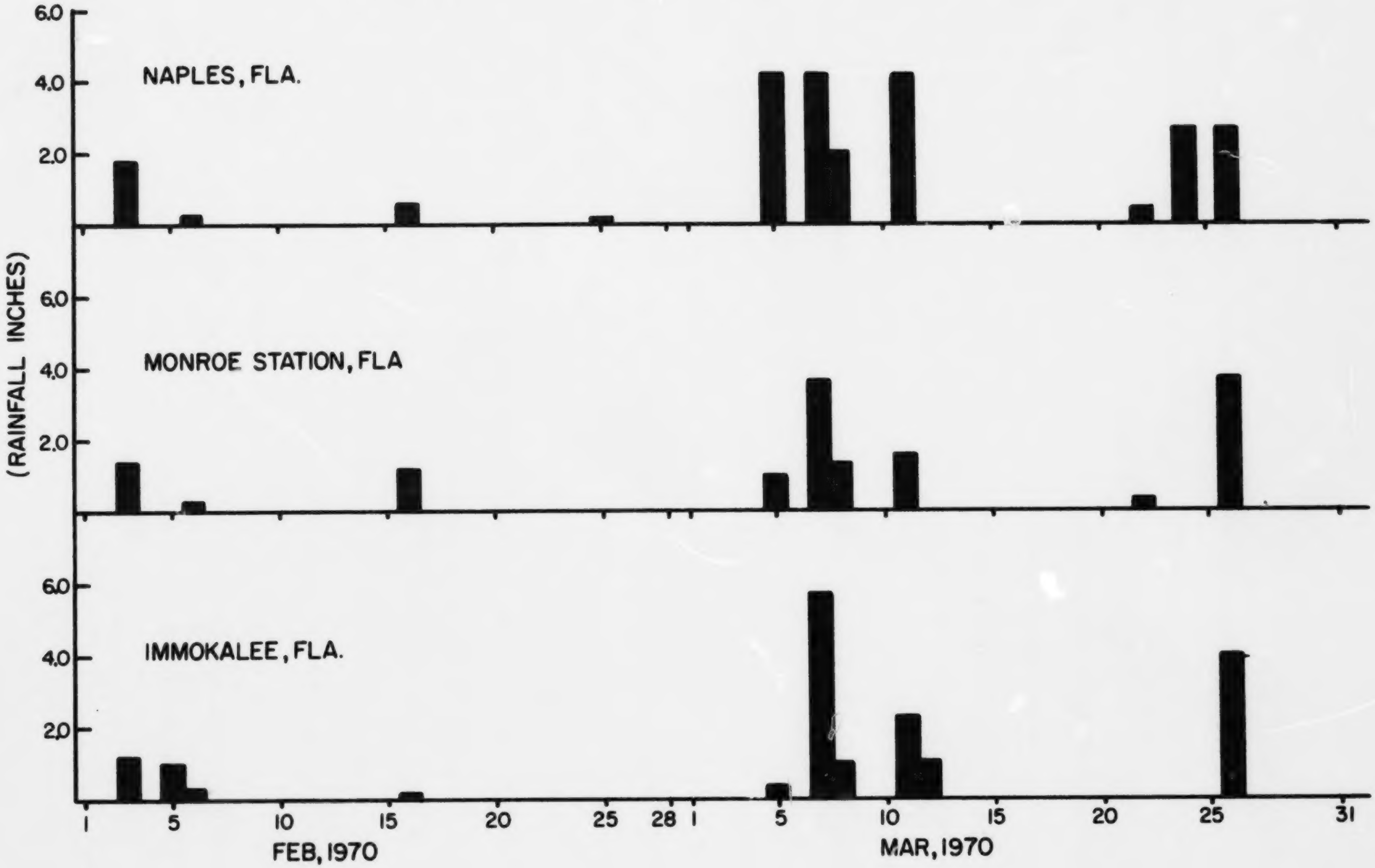


FIGURE 5
STREAMFLOW AT LOWER BIG CYPRESS GAGING STATIONS

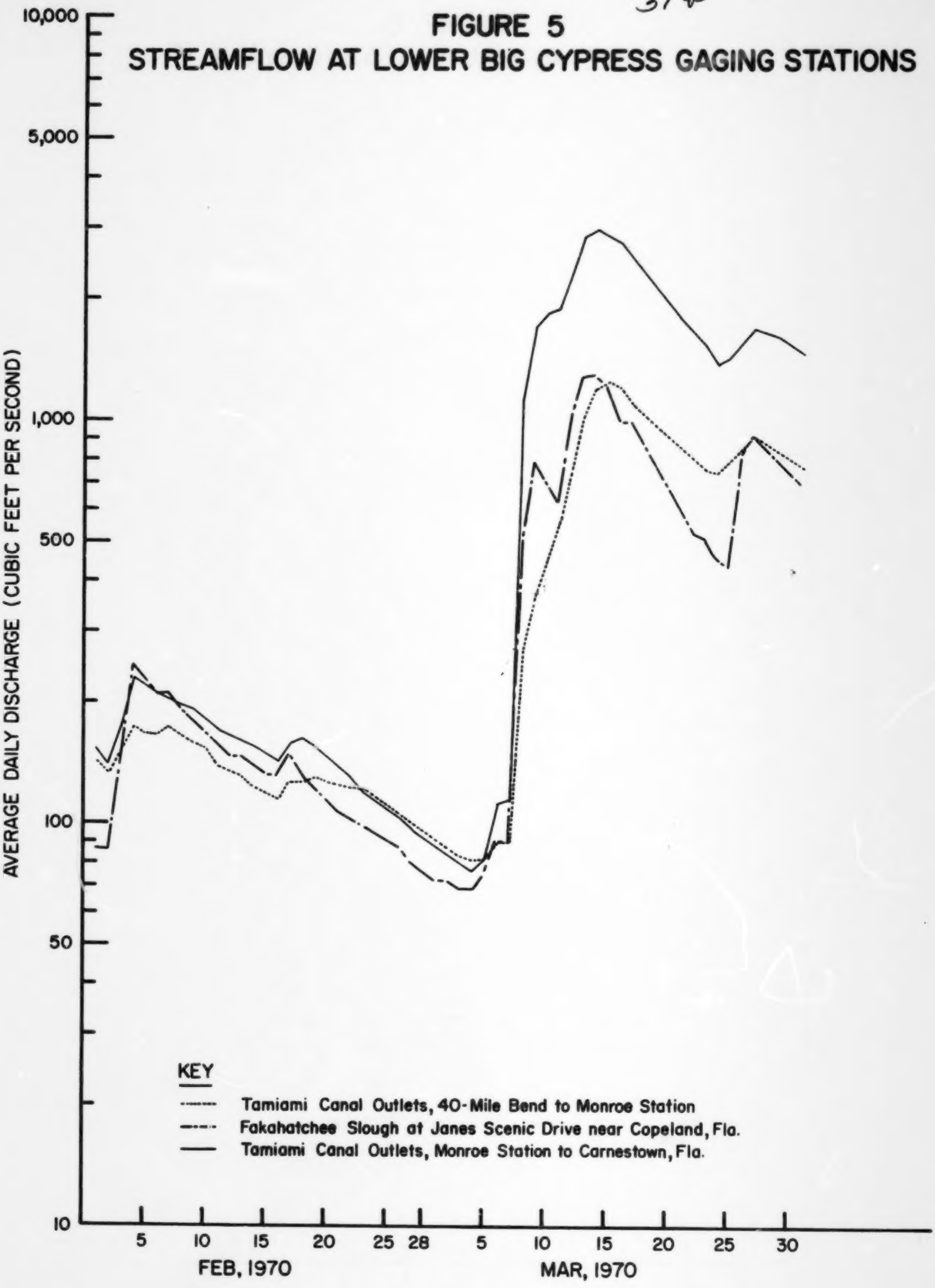
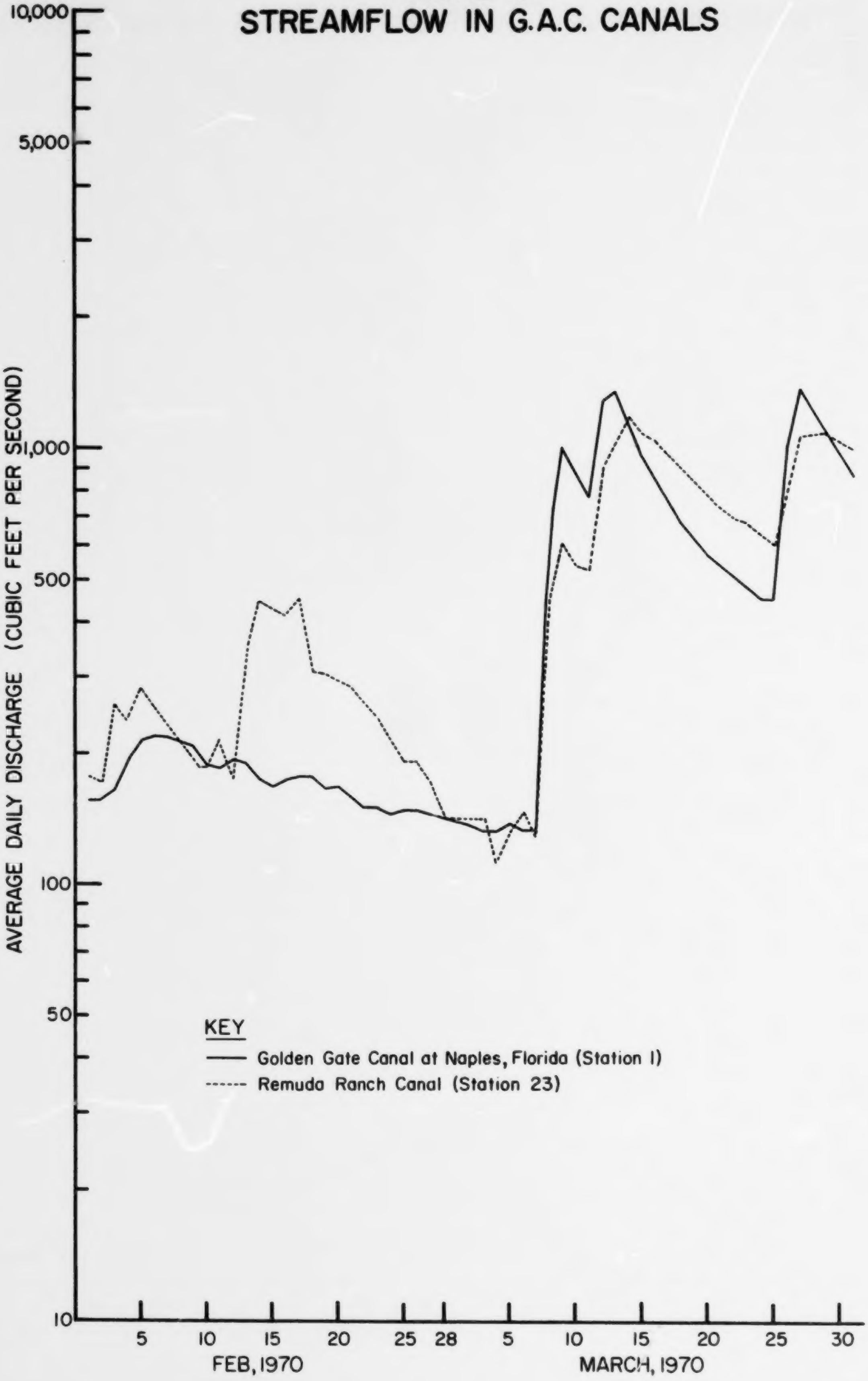


FIGURE 6
STREAMFLOW IN G.A.C. CANALS



Monroe Station, the total flow for March alone (41,000 acre-feet) was approximately 25 percent of the annual total. In the Monroe Station to Carnestown reach, total March flow (93,200 acre-feet) was almost 50 percent of the annual total.

It is interesting to note that the combined March flow carried by the two GAC collector canals (Figure 6) was almost 50 percent of the total annual overland flow entering the Everglades National Park in the Monroe Station to Carnestown reach. The high flows now entering coastal waters directly from these two canals, over 1,000 cfs at times, was formerly available at both sheet flow which sustained the Big Cypress-Everglades ecology and as groundwater recharge.

Flow data (not shown) for the Highway 29 Canal (Barron River) and Alligator Alley Canal outlets displayed a monthly variation cycle similar to that in other portions of the Swamp.

The preceding discussion of rainfall and runoff serves to emphasize that the normal March dry weather, low water level conditions did not occur in 1970. Thus, one of the expected study conditions did not materialize. The rainfall and runoff patterns which occurred did permit the study of swamp system flushing caused by heavy rainfall. The first two days of sampling, March 4 and 5, followed an extended drying period.

WATER QUALITY IN THE BIG CYPRESS SWAMP

The following discussion of water quality in the study area is intended primarily to contrast differences in quality, especially between developed and undeveloped areas. Biological characteristics are included in the discussion.

Habitat Types

The Big Cypress Swamp is not merely a stand of large cypress trees. It is a subtropical area of various plant communities, many of which result from an ecological response to the water level. Although the area is considered to be aquatic, there are relatively dry portions that support pine trees and saw palmetto. In contrast, there are pools and sloughs that contain water nearly year-round. In order to understand the area called the Big Cypress Swamp, one must first know of its various interrelated components or habitats.

The Pine Flatwoods - As in the Everglades, the topography of the Big Cypress Swamp is extremely flat. An elevation of just a few inches above the surrounding area minimizes the inundation duration or hydroperiod. It is in these elevated places that the driest habitat of the Big Cypress area has developed. The area is known by various names including pine flatwoods, pineland, the pine hammock and the slash pine forest. Each name given the area is an attempt to describe this habitat. It is a forest of pine and saw palmetto. In areas of richer soil, the forest association includes cabbage palm and mixed hardwoods, but the slash pine (*Pinus elliotti* var. *densa*) is the dominant feature. This forest type is subjected to the highest wildfire frequency in the Big Cypress area. These fires probably help maintain the pine dominance. The understory is primarily hardwood saplings mixed with saw palmetto (*Serenoa repens*). If the forest were to climax, i.e. reach a stable community, hardwoods would undoubtedly shade the pines and the result would be a hardwood forest. However, during the dry season, the understory provides fuel for wildfires, while the pines with their long trunks standing aloft are virtually fireproof. During the March survey sampling was done in canals draining from this dry habitat.

The Hardwood Hammock - A second forest type common to the Big Cypress area is the hardwood hammock. This habitat of broad-leafed trees is found scattered throughout much of the area. It is as common to lower elevations in the pinelands as it is to drier reaches of swamp. In larger natural stands, this forest type consists of pine, cypress, bay, magnolia, coccoplum and other typical trees of the southeastern United States and the West Indies. In recent years, many of the more accessible stands of pines and cypress have been removed for lumber. Wildfires that followed severely burned the remaining hardwood hammocks. These areas now show mute evidence of the cutting and burning as they have regrown into a dense entanglement of willow (Salix carolinians and S. amphibia) and red maple brush (Acer rubrum).

The Cypress Swamp - The major forest type is the bald cypress (Taxodium distichum) for which the area is named. As mentioned previously, many larger, commercially valuable cypress have been cut for lumber. Thus, the cypress swamp habitat today is characterized in many places by scrub cypress in association with bay, ash (Faxinus caroliniana), maple and other swamp hardwoods. Of the habitats mentioned thus far, the cypress swamp has the longest hydroperiod.

During the March 1970 survey, a biological sampling site (Station 28) was selected in this aquatic habitat. Water levels increased in the cypress swamp because of heavy rainfalls early in the month. However, this habitat is characterized by pronounced fluctuations in water level and these rains probably had little effect on the native biota. Figure A-12 is a diagrammatic transect of the sampling site showing the water level during the biological collecting period. The shallow waters teemed with schools of topminnows and sunfish feeding upon a diversity of aquatic invertebrates. Wood storks, various egrets, and herons also feed on these fish. A list of the biota observed and collected in this habitat is presented in Appendix C.

The Wet Prairie - An important herbaceous habitat that lies in elevation between the pine flatwoods and cypress swamp is the wet prairie. This treeless area is a mixed grass-sedge marsh. Since it is periodically dry, it contains little or no sawgrass. Throughout southern Florida, this type habitat is being drained. The substrate is then cultivated intensively. A biological station

(Number 33) was located within an undisturbed prairie. A quadrat of the sample site is shown in Figure A-15. The native biota and their relative abundance are presented in Appendix C.

The Sawgrass Marsh - The Big Cypress Swamp and the Everglades comprise a single ecological entity. The "vegetative bridge" between the two areas is the sawgrass marsh. In the Big Cypress, this marsh differs somewhat inasmuch as dwarf cypress trees are sprinkled throughout the "sea of grass." The sawgrass marsh is located on lower ground than the wet prairie and has a long or continuous wet period. Normally, water levels remain high from the summer months through November when they gradually decline to a low in April. March 1970 was an exceptionally wet period in the marsh areas. Water levels are shown for the sampling site (Station 34) in Figure A-16. Faunal populations were undoubtedly decreased by this high water. Specific data on biotic conditions are presented in Appendix C.

The Slough - Although water movement in the Big Cypress Swamp is often imperceptible, it does move slowly in a southerly direction. Topographic depressions in the form of wide, shallow channels form natural drainage canals. These channels are referred to as sloughs. The largest slough in the Big Cypress area is known as Fakahatchee Strand. It drains the southwestern Big Cypress. Station 21 was located within this slough. Figure A-9 shows the topography of the quadrat studied.

During the dry season, the sloughs and a few ponds often constitute the only natural aquatic habitats. Because the sloughs are flooded most of the year, their aquatic life is diversified and abundant. Appendix C presents a list of the biota collected and observed in the Fakahatchee Slough.

The Cypress Pond - During the dry season and especially during extreme drought, aquatic habitats may be reduced to only the deepest sloughs and ponds.

Wet prairie

Cypress swamp

35b

Sawgrass marsh

The origin of these ponds varies from limestone solution holes or burned out pockets in the peat to holes dug by large alligators or perhaps by man in search of limestone. Regardless of their origin, these ponds become the survival holes for aquatic forms during low water periods. They are called alligator holes, although they support a vast population of life forms in addition to alligators. Station 32 was located in a pond in Fakahatchee Strand. The morphometry of the section of the pond studied is shown in Figure A-14. Again, the water levels during March 1970 were abnormally high and biotic population was not concentrated in the ponds. This is illustrated by comparing the biota collected or observed in the pond with the populations of other aquatic habitats studied (Appendix C).

Canals - The many artificial canals form another major aquatic habitat in the Big Cypress area. This habitat is continuously wet and presently represents the only freshwater stream-type environment in this part of Florida(6) As the canals age they become uniform habitats supporting pond or lake-type invertebrate fauna and plant life such as water hyacinths, naiads, bladderworts, and other pond or slow-running water forms. Ecological differences between canals are closely related to nearby land uses.

In newly constructed canals, plant life is not well established. Invertebrate organisms associated with the flora are sparse also. Station 18 is an example of this canal stage. As the canal ages, the aquatic life increases, and in areas without extensive land development, the canal biota develop into forms similar to those observed in natural sloughs. A typical example of this type canal is Station 17.

Many canals have been developed into waterways with houses and various commercial activities along their banks. These canals are being altered constantly by mechanical or spray removal of floating biota.[1/] Because of this removal and the varied shoreline activities, these canals do not always have similar ecological

---

[1/] Clandestine disposal of solid wastes (garbage) was observed in some areas.

succession. Comparisons are difficult, and it is best to consider such canals individually. Examples of the developed shoreline canal are Stations 1 and 23.

Physical Quality

The physical water quality characteristics examined in the Big Cypress study area included temperature, pH, turbidity, color, conductivity, and light penetration. A summary of physical data appears in Appendix C.

Light Penetration - One of the early findings of the March survey was that at the water levels which existed, light penetrated the entire water column at most stations (Table IV). This was not an unusual finding for southern Florida or Florida in general for that matter. The flat topography, which discourages erosion, the sandy soil which is generally free from silt, and the predominance of attached primary producers (as opposed to planktonic forms) all help produce waters of high clarity. The effect of a euphotic zone throughout the entire depth is to encourage the growth of aquatic plants in all light-exposed areas.

Temperature - With the exception of one area of the Big Cypress Swamp, water temperatures during March generally averaged between 20 and 22°C (68 to 72°F). In the heavily shaded Fakahatchee Strand area on Janes Scenic Drive, the average temperatures were lower, between 18.5 and 19°C.

Figure 7 illustrates the monthly temperature ranges by station groups. The Fakahatchee Strand area showed the widest monthly range. Station 20 temperatures ranged from 15°C to 22°C. It is thought that temperature extremes in the Fakahatchee area are more typical of those which occur in the many shallow water sloughs spread throughout the Big Cypress. Temperature ranges for the month were less in the canals, probably because of greater water volume.

During the warmer months, and especially in dry periods, water temperatures in unshaded canals have been reported to exceed 90°F.(7)

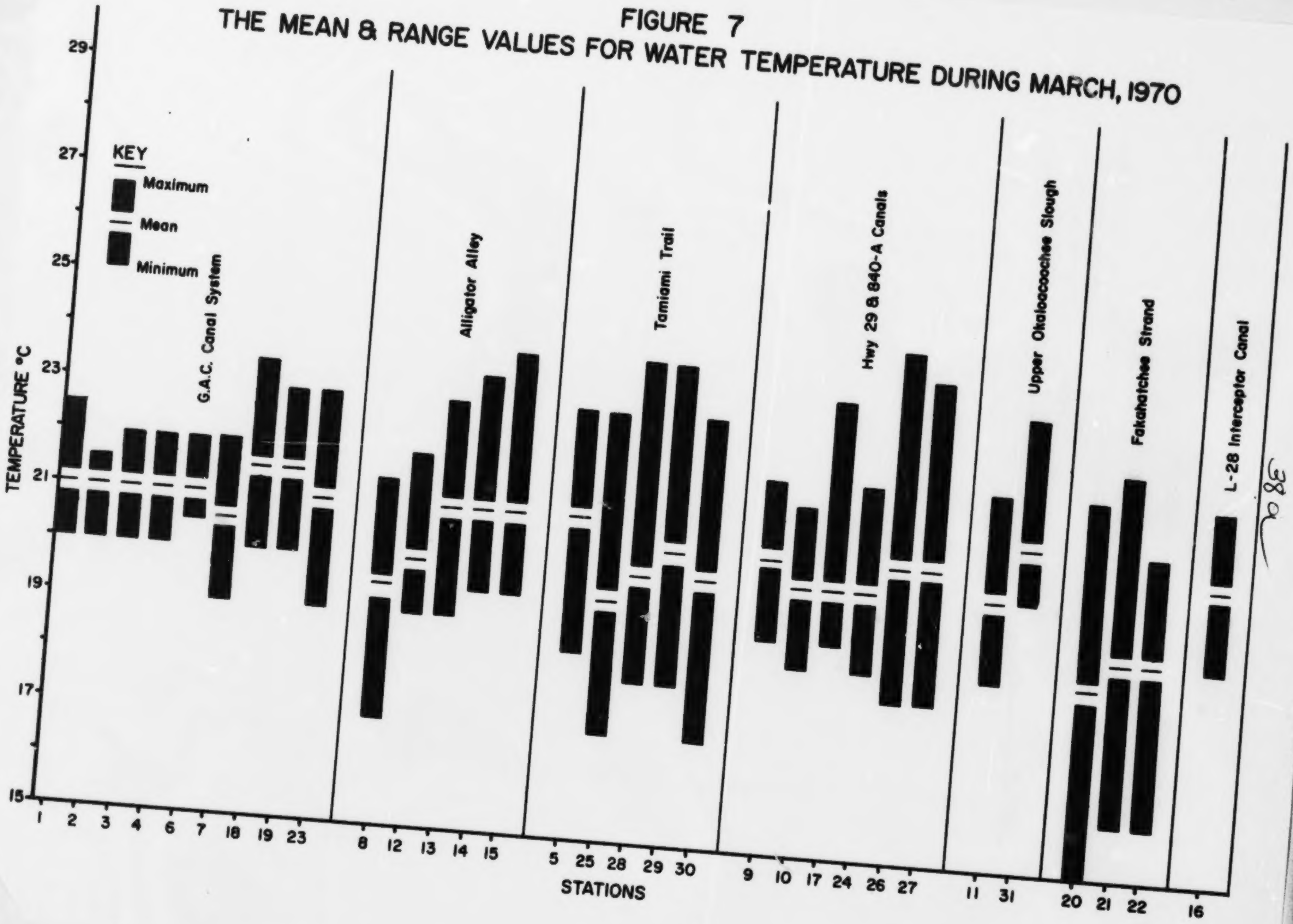
TABLE IV

SECCHI DISC TRANSPARENCY

STATION	DATE	TIME	WATER DEPTH (METERS)	SECCHI DISC READING DEPTH (METERS)
1	3-13-70	1000	1.6	1.2
2	3-5-70	0930	0.8	0.8
3	3-5-70	0950	0.9	0.9
4	3-3-70	1200	1.0	0.4
5	3-16-70	1215	2.6	2.6
6	3-5-70	1015	1.0	1.0
7	3-5-70	1030	2.0	2.0
8	3-5-70	1050	1.3	1.3
9	3-5-70	1110	3.0	3.0
10	3-5-70	1210	1.0	1.0
11	3-20-70	1130	2.2	1.4
12	3-5-70	1320	1.8	1.8
13	3-5-70	1345	1.5	1.5
14	3-23-70	1130	2.9	2.2
15	3-5-70	1415	1.5	1.5
16	3-19-70	1130	4.9	0.8
17	3-23-70	1215	1.9	1.9
18	3-6-70	1500	4.4	1.3
19	3-9-70	1200	1.0	0.3
20	3-4-70	1130	0.8	0.8
21	3-4-70	1215	1.0	1.0
22	3-4-70	1145	0.7	0.7
23	3-6-70	1200	4.6	0.8
24	3-4-70	1345	1.7	1.7
25	3-4-70	1355	1.8	1.8
26	3-4-70	1720	1.0	1.0
27	3-10-70	1200	1.8	1.8
28	3-11-70	1300	1.6	1.6
29	3-29-70	1230	2.6	2.6
30	3-4-70	1545	1.5	1.5
31	--	--	-	-
32	3-18-70	1215	2.7	2.7
33	3-18-70	1300	0.1	0.1
34	3-16-70	1030	0.5	0.5

FIGURE 7

THE MEAN & RANGE VALUES FOR WATER TEMPERATURE DURING MARCH, 1970



pH - The pH values in the Swamp (Table C-I) are indicative of both dissolved mineral quality and biological activity. The latter can and does effect diurnal changes in pH. The CO_2 produced by bacteria and present naturally in Swamp waters is a metabolic requirement of plant forms. Photosynthetic activity during daylight hours will result in uptake of CO_2 and an increase in pH.[1] Buffer capacity of the waters also affect pH values. Values averaged slightly basic at all sampling sites except Stations 10 and 11 where averages were 6.9 and 6.8 respectively. The highest average monthly pH (7.6) was found at Station 25. No unusual pH differences between developed and undeveloped areas of the Swamp were noted from the daily sample data. Hourly studies discussed later were more revealing.

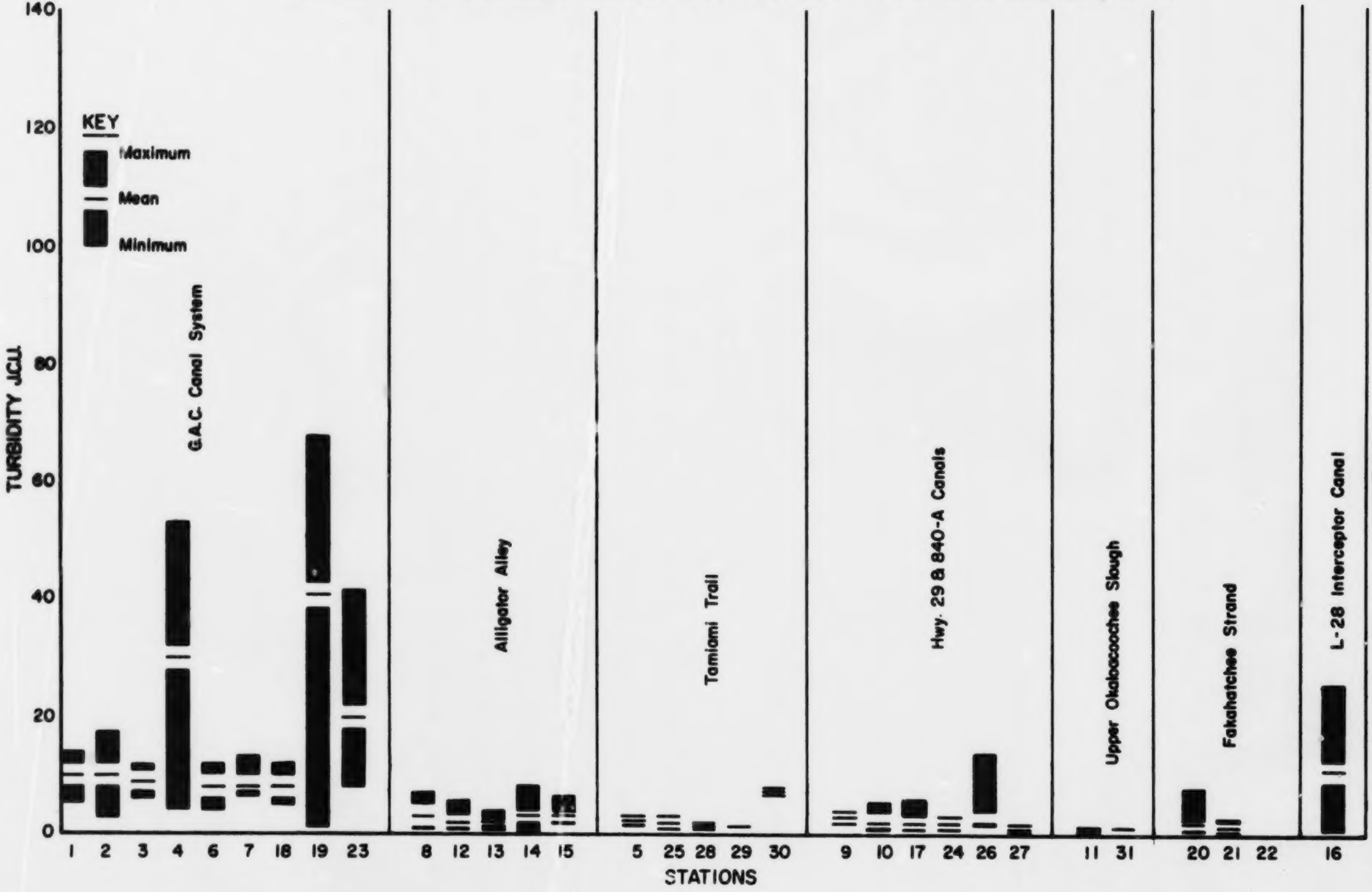
Turbidity - Unlike pH, the daily turbidity values revealed distinct differences between the developed and undeveloped Big Cypress areas. In the flat terrain and heavily vegetated lands of southern Florida, it is unusual to find natural waters with noticeable turbidity problems. Color may be high but the water transparency is usually excellent. Low turbidity is characteristic of the natural, undisturbed sections of the Swamp. In newly constructed canals or those draining cleared land, there were noticeable turbidity differences. At Stations 4 and 19, maximum turbidity values were 53 and 68 units respectively and averaged 30 and 41 units. Station 4 drained an agricultural area and a portion of GAC Corporation land being cleared for development, while Station 19 was immediately downstream from an active dredging project. Other stations with average turbidities greater than 10 units were Stations 1, 16, and 23. All of these stations were in relatively new canals. Figure 8 shows the turbidity variations.

---

[1] Hourly variation studies are described in greater detail in a subsequent section.

FIGURE 8

THE MEAN & RANGE VALUES FOR TURBIDITY DURING MARCH, 1970



Following each heavy rainfall during the month, turbidity values increased at most stations. This is a reflection of the flushout of suspended matter in natural Swamp areas and of erosion in the areas drained by canals (including erosion within the canals and from adjacent spoil disposal banks). Turbidity variations caused by rainfall were more pronounced in the drainage canals than elsewhere.

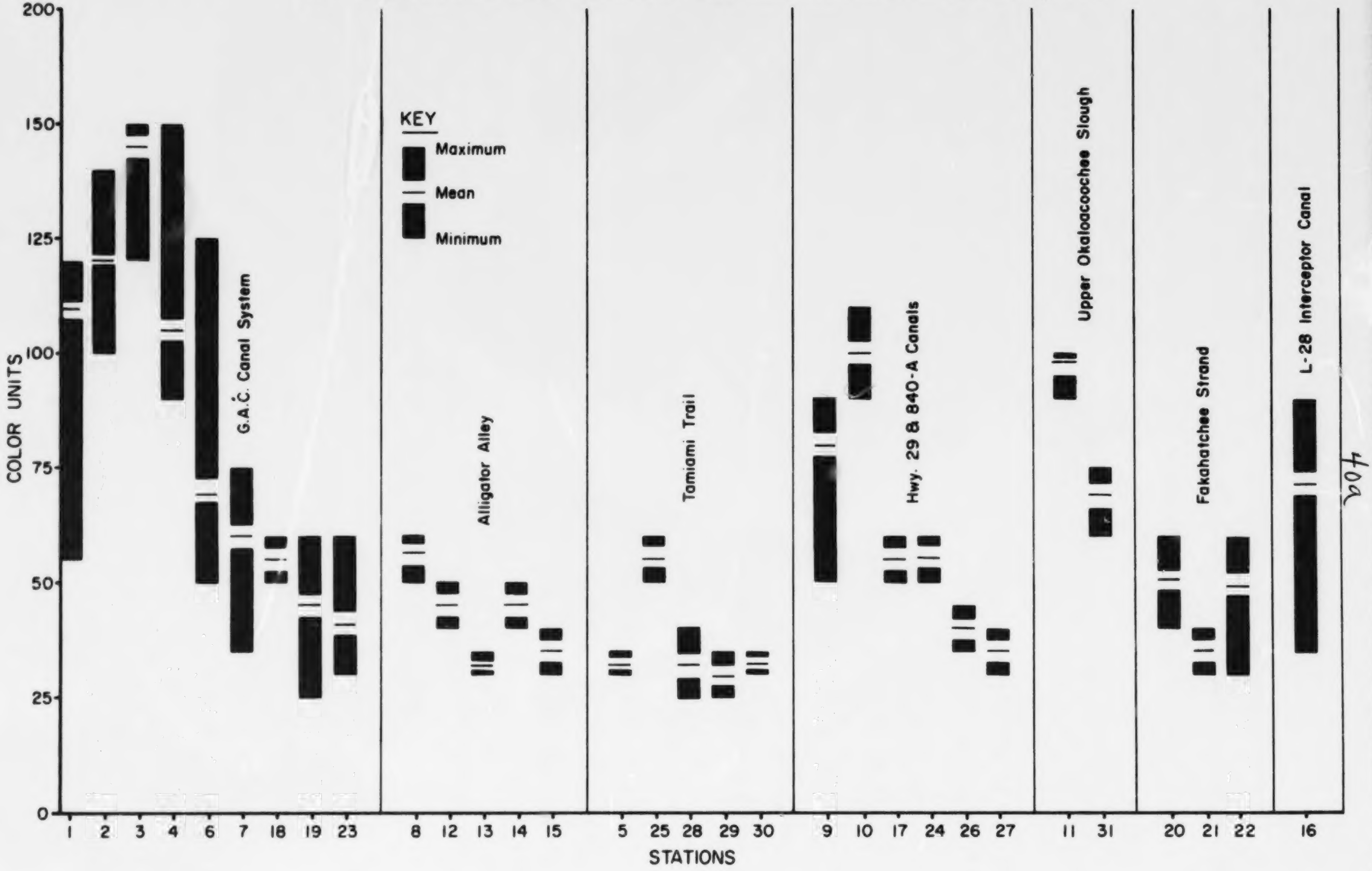
In comparing water quality between developed and undeveloped Big Cypress areas, the differences shown by the turbidity data were among the most significant. Higher turbidity in canals was a causative factor in decreased biological activity and was generally reflective of a disturbance in the natural Swamp ecology. Damage to the water quality of coastal receiving waters at the mouths of canals is likely. More development through drainage will increase the water quality problems indicated by the turbidity data.

Color - Figure 9 shows the average color value and monthly range at the sampling stations. Typical stained waters were found in all sections of the Swamp, but highest average color values (those over 75 units) were found generally in the GAC and Highway 29 area. Color in undeveloped Swamp areas averaged less than 60 units. Again, man's disturbing influence on the Swamp is evidenced by the color analysis data. Ecological damage resulting from high color relates primarily to reduced photosynthetic activity. Excessive color (over 20 units) can also interfere with water supply uses unless removed by treatment.

The actual cause of higher color values in the developed and developing area canals was not determined. There could be a relationship between color and the death of plant forms normally associated with aquatic habitats, where these habitats are being eliminated through drainage.

FIGURE 9

THE MEAN & RANGE VALUES FOR COLOR DURING MARCH, 1970



Conductivity - The daily conductivity values recorded in Table C-I are related directly to the dissolved solids content of waters in the study area. No further mention will be made at this point other than to say that the data showed conductivity to be approximately twice as high in GAC canals as in waters elsewhere in the Swamp.

Chemical Quality

The chemical quality characteristics examined on a daily basis are listed in Table III. Analytical results are summarized in Appendix C .

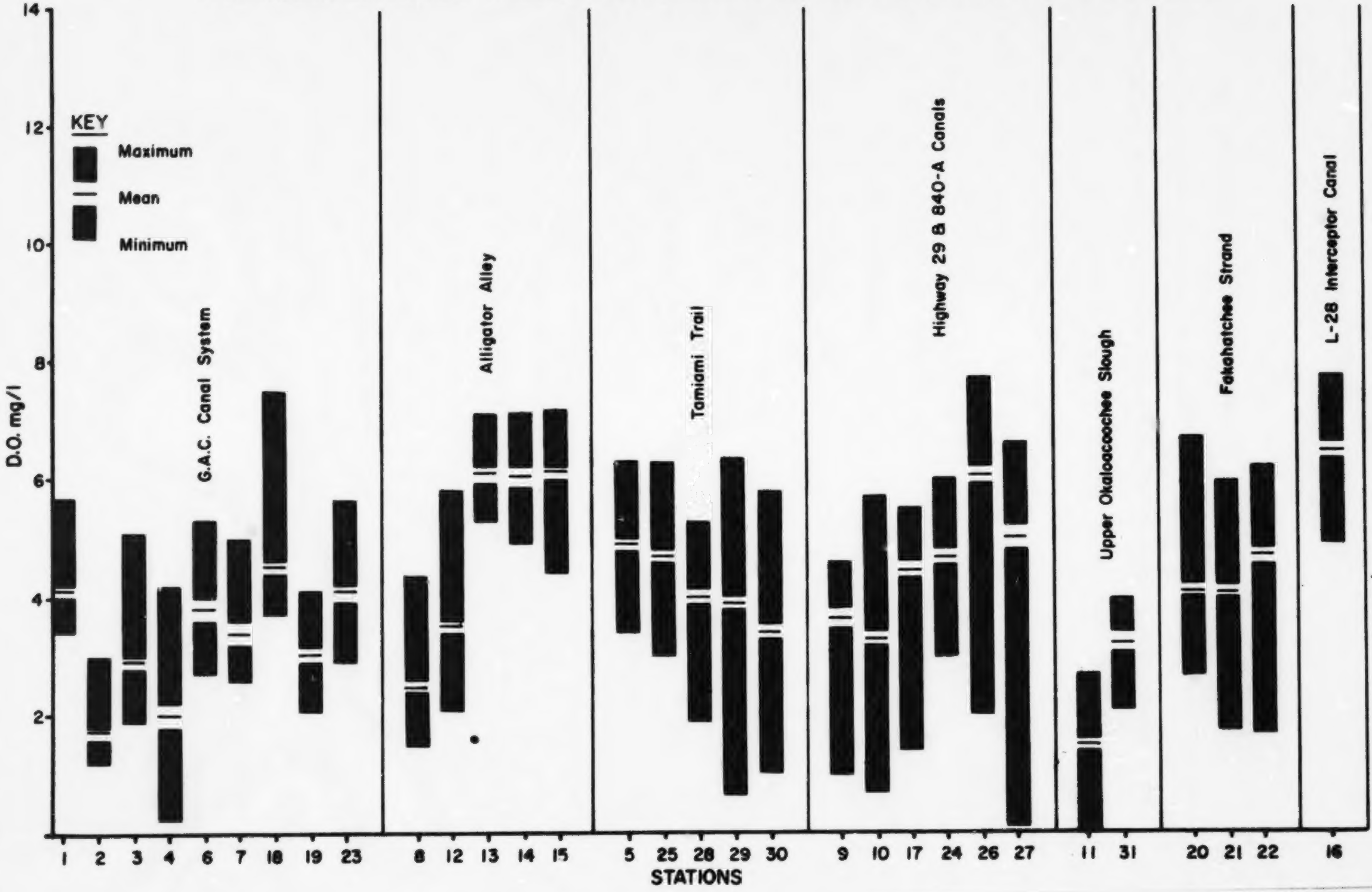
Dissolved Oxygen - Results of daily dissolved oxygen (DO) analyses are shown in Figure 10. The DO content of waters in the Big Cypress was highly variable and reflected biological activity to a large degree. Samples taken during the a.m. were lower, sometimes appreciably, than those observed in the p.m. This is a normal pattern indicative of the DO production and uptake rate which occurs during a representative diurnal period in any water body with bacterial and aquatic plant forms present. The range of DO concentrations can provide insight into those areas with the greatest biological activity. These ranges are best determined on a diel basis, and studies of this type are discussed in a later section.

From the grab sample data, no significant differences between dissolved oxygen concentrations in developed and undeveloped areas could be discerned (Figure 10). Oxygen values less than 1 mg/l were found in several different and widely separated Swamp areas, e.g. GAC canals (Station 4), Tamiami Trail (Station 29), Highway 29 and 840A canals (Stations 10 and 27), and in the Upper Okaloacoochee Slough (Station 11). Near zero DO levels were detected at times at Stations 4, 11, and 27.

Dead fish were found (and reported by others) in many of the areas where DO levels were lowest, e.g. Tamiami Trail at Station 29. Indications are that this is a natural phenomenon. The low DO values in the Big Cypress Swamp are similar to values in other swamp-like areas of the Southern United States.

FIGURE 10

THE MEAN & RANGE VALUES FOR DISSOLVED OXYGEN DURING MARCH, 1970



Maximum DO concentration approached 7 mg/l and reflected saturation values less than 80 percent. The absence of supersaturation conditions tends to indicate that excessive nutrient enrichment, i.e. accelerated eutrophication, was absent, at least during March. Average DO values were generally 5 mg/l or less, but since samples were taken more frequently during the morning hours, it is felt that the average results were slightly biased on the low side.

A complete analysis of dissolved oxygen in the Swamp system would require a long-term study over at least one complete annual cycle.

Alkalinity and Total Hardness - The results of both hardness and alkalinity analyses revealed significant differences in quality between the GAC canal stations and other sampling sites in the Swamp. Figures 11 and 12 depict mean, maximum, and minimum values for these two water quality characteristics at all sampling stations. Day-to-day variations for hardness at selected stations are shown in Figure 13.

In the GAC canal system, the average hardness, which varied from 220 (Station 7) to 450 (Station 2) mg/l, was approximately two times higher than in other Swamp areas. Likewise, average alkalinity was approximately 100 mg/l higher in GAC canals, up to 310 mg/l at Station 18. These striking quality differences were related directly to the sources of water in the two areas. Canals are designed and constructed in swampy areas to drain both surface and near-surface groundwaters in lands to be cleared and developed. This was being accomplished successfully in GAC lands. The higher alkalinity and hardness concentrations were a direct reflection of groundwater seepage into the canals. Elsewhere in the Big Cypress in March, even in other canals,

FIGURE 11
THE MEAN & RANGE VALUES FOR ALKALINITY DURING MARCH, 1970

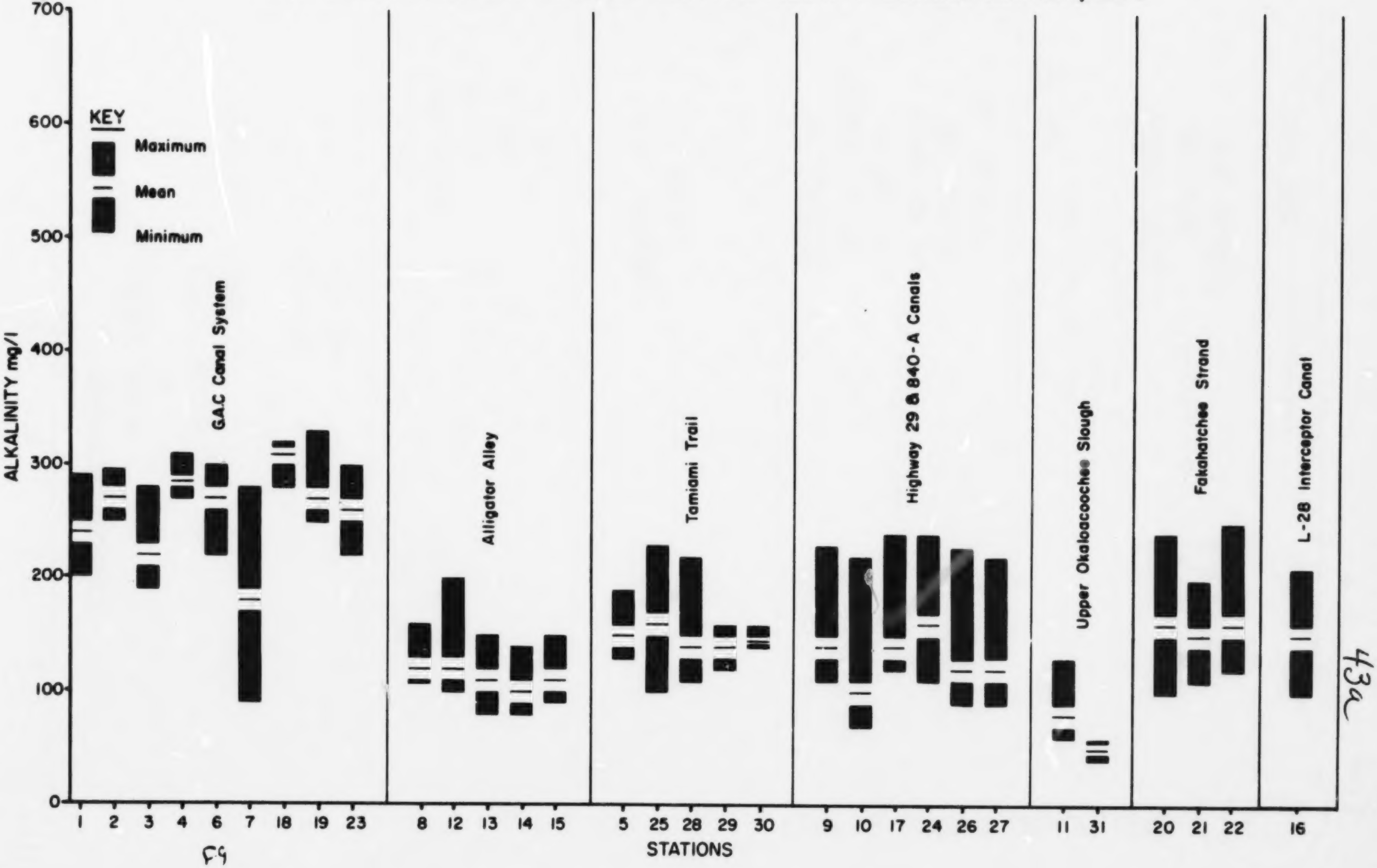


FIGURE 12
THE MEAN & RANGE VALUES FOR TOTAL HARDNESS DURING MARCH, 1970

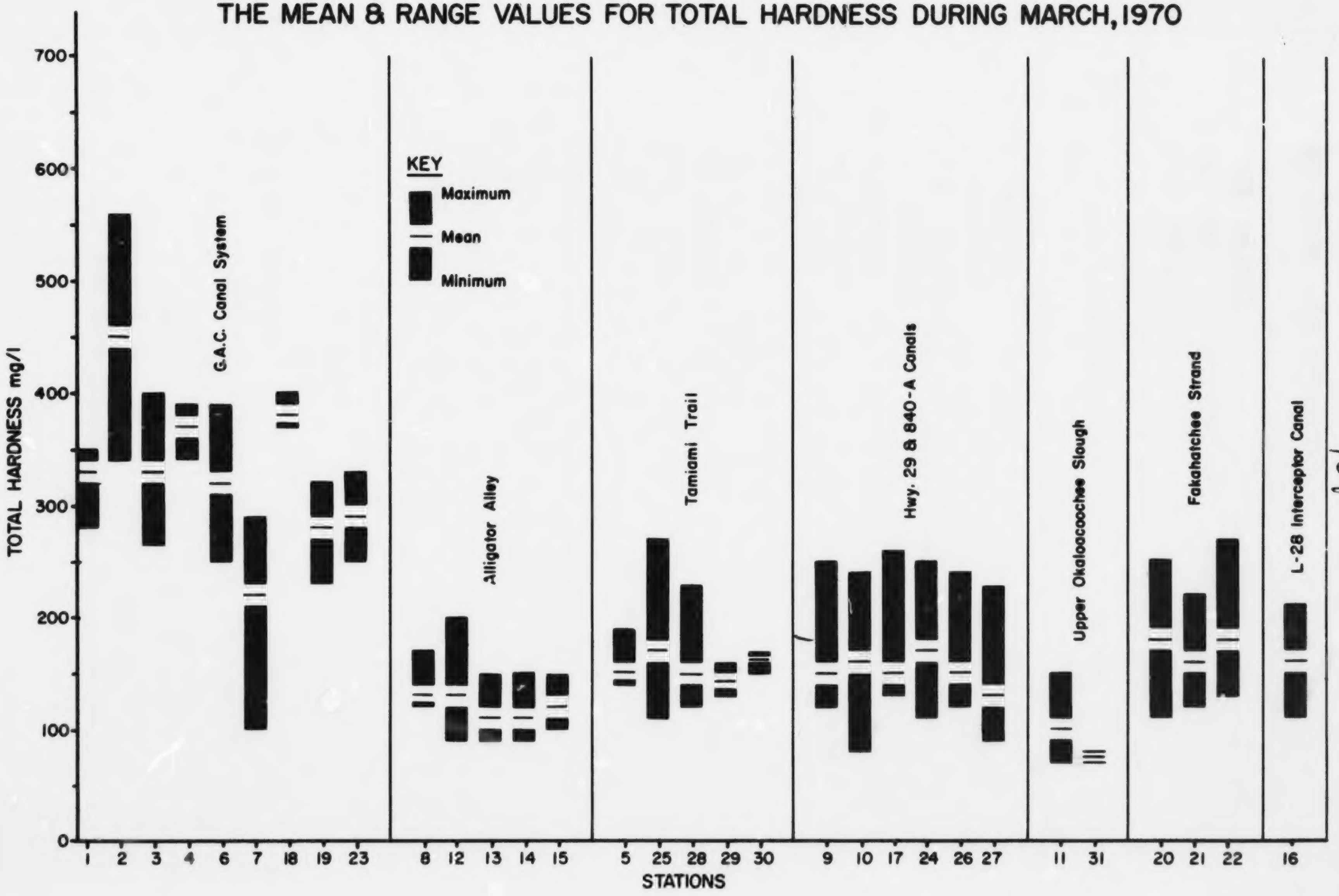
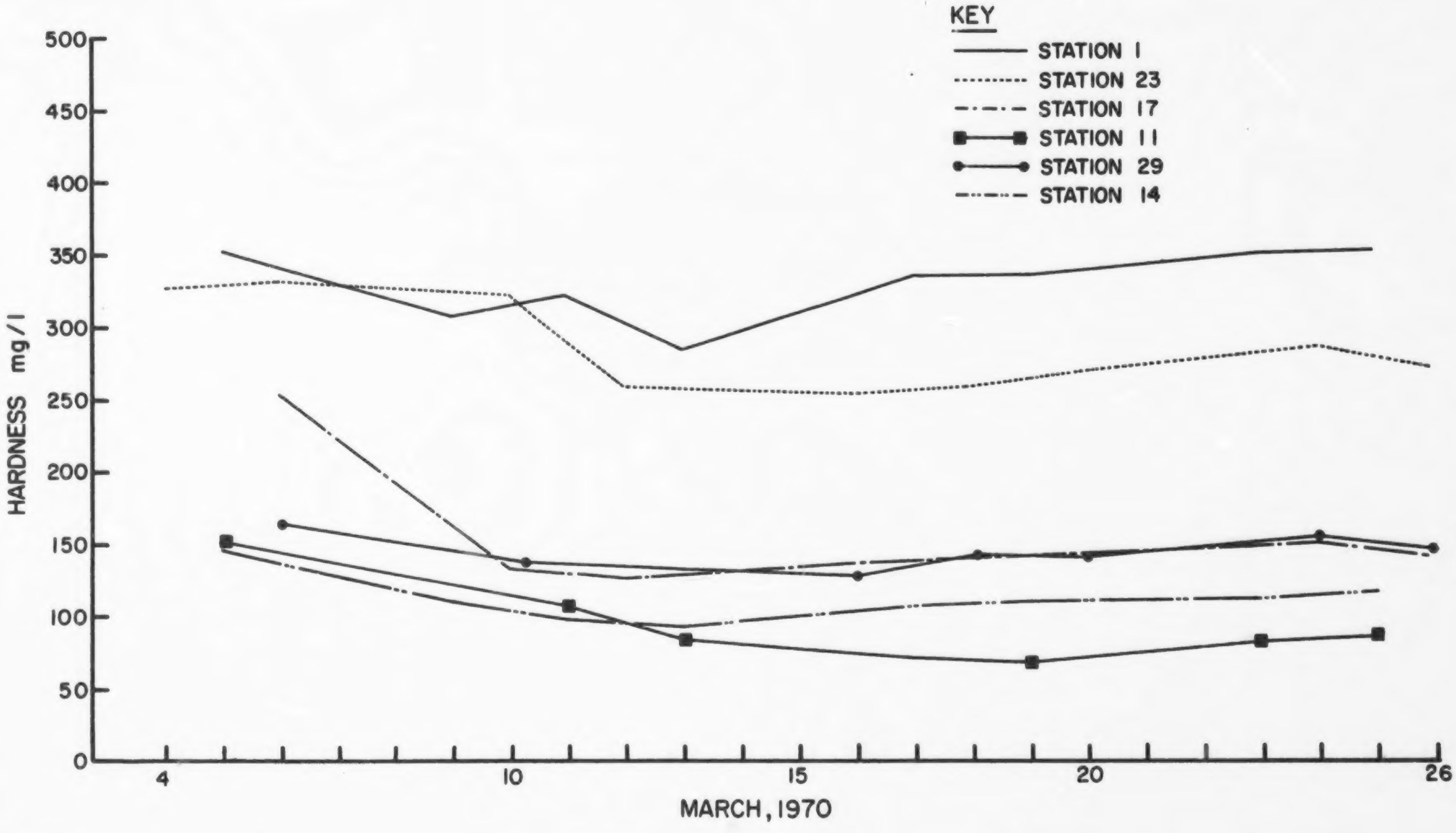


FIGURE 13
DAILY HARDNESS VALUES AT SELECTED STATIONS DURING MARCH, 1970



surface runoff was the principal source of water. Surface runoff has less dissolved mineral constituents, and therefore lower concentrations of hardness and alkalinity. The daily fluctuations in hardness concentrations were influenced by the rainfall pattern. Figure 13 clearly shows the effect of rainfall at several stations.

The GAC canals convey waters, which can be characterized as very hard, into areas where such quality waters were not present prior to canal construction. The effects on the ecology of receiving waters was not investigated in this study but should be evaluated, especially in the Ten Thousand Islands region. The large volume of canal water entering Fahka Union Bay will certainly change salinity patterns over a wide area and could possibly effect changes in the ecosystem as a result of the chemical character of the canal-conveyed waters.

The GAC Corp. canal system is draining groundwater away from the heavily used shallow aquifer immediately east of Naples. This is another detrimental effect on water resources associated with the land development pattern evolving in extreme southern Florida. The easternmost GAC canal (northeast of Station 23) is intercepting natural overland sheet flow in Fakahatchee Strand and is diverting it away from its natural course into the Everglades. This will eventually damage both the Strand and the Everglades National Park.

Waters in upper Okaloacoochee Slough had the lowest hardness and alkalinity concentrations in the Swamp, averaging 80 and 96 mg/l respectively at Station 11. This was expected since this is a "headwaters" area of the Big Cypress which precedes the more characteristic swamp-like regions. Heavy rainfall during March influenced the alkalinity and hardness concentrations observed.

Sulfate - The sulfate analysis data (Figure 14) showed the same pattern as did the hardness and alkalinity results and for the same reasons. Differences between the GAC Corporation land area and other Big Cypress regions were even more striking, however. In undisturbed Swamp areas, sulfate concentrations were generally reported as less than 3 mg/l. GAC canals such as at Station 2, had sulfates as high as 170 mg/l.

Since sulfur content can effect changes in the biotic character of water areas, it is significant that sulfur (in the form of sulfate) enters some coastal areas from canals in amounts much higher than that which previously occurred naturally. The effects of increased sulfur input need further study.

Total Dissolved Solids and Chlorides - Three grab samples from each sampling station were obtained during each of the last three weeks of the March study and analyzed for total dissolved solids (TDS) and chloride content. Analytical results are contained in Table C-II. Figure 15 shows chloride extremes at the various stations.

With one exception discussed in the following paragraph, the TDS results conformed to the pattern of hardness, alkalinity, and sulfates discussed previously. At one time there was some question concerning salt water encroachment at Station 25. Since the maximum TDS concentration was only 244 mg/l, saltwater encroachment was ruled out during March.

Chloride concentrations were consistent with the hardness and sulfate trends at all but Station 18 in the GAC canal system. The chlorides there ranged from 104 to 120 mg/l, at least twice as high as any other station. Total dissolved solids concentrations at Station 18 (587 to 606 mg/l) also

FIGURE 14
DAILY SULFATE VALUES AT SELECTED STATIONS DURING MARCH, 1970

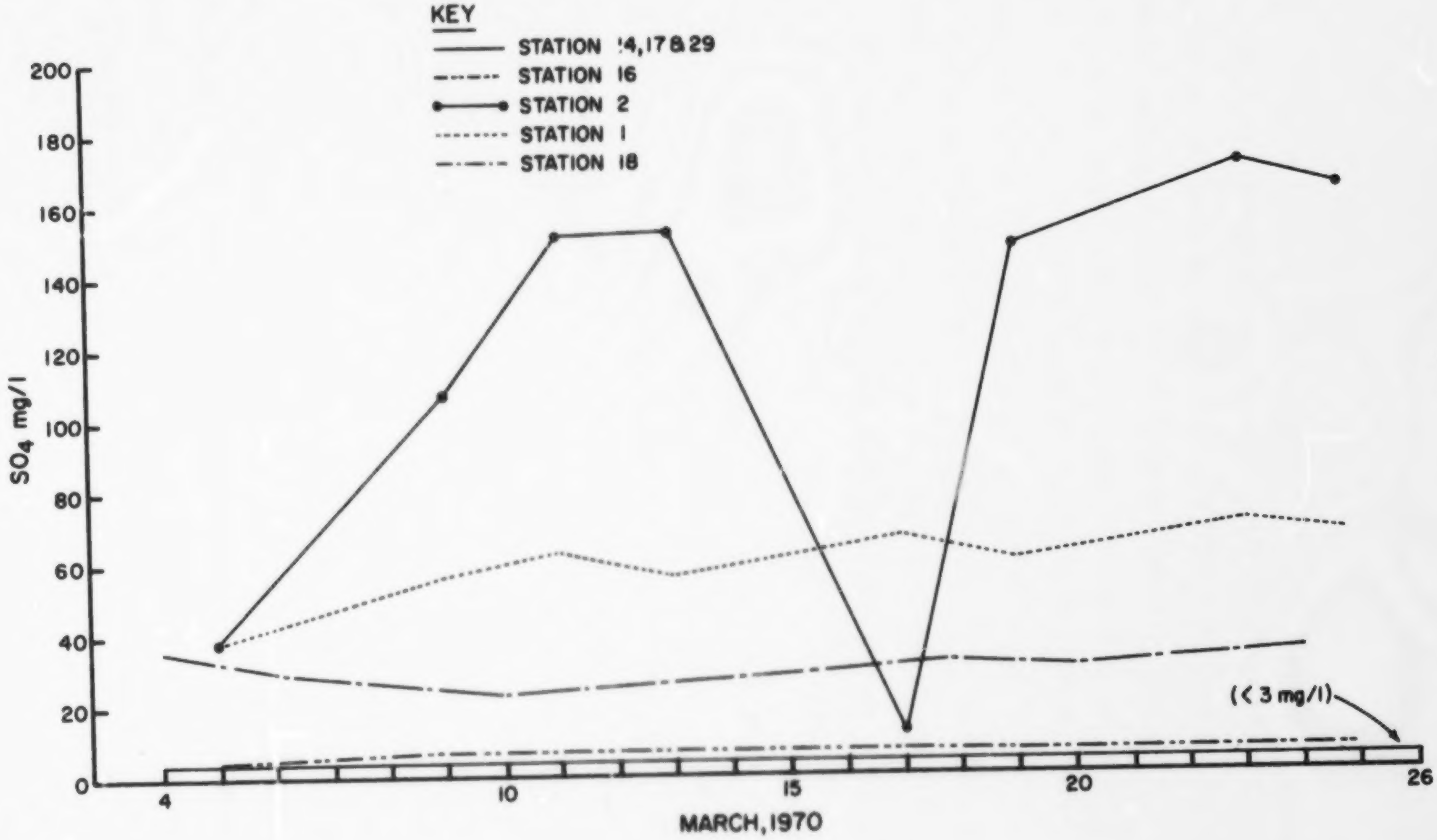
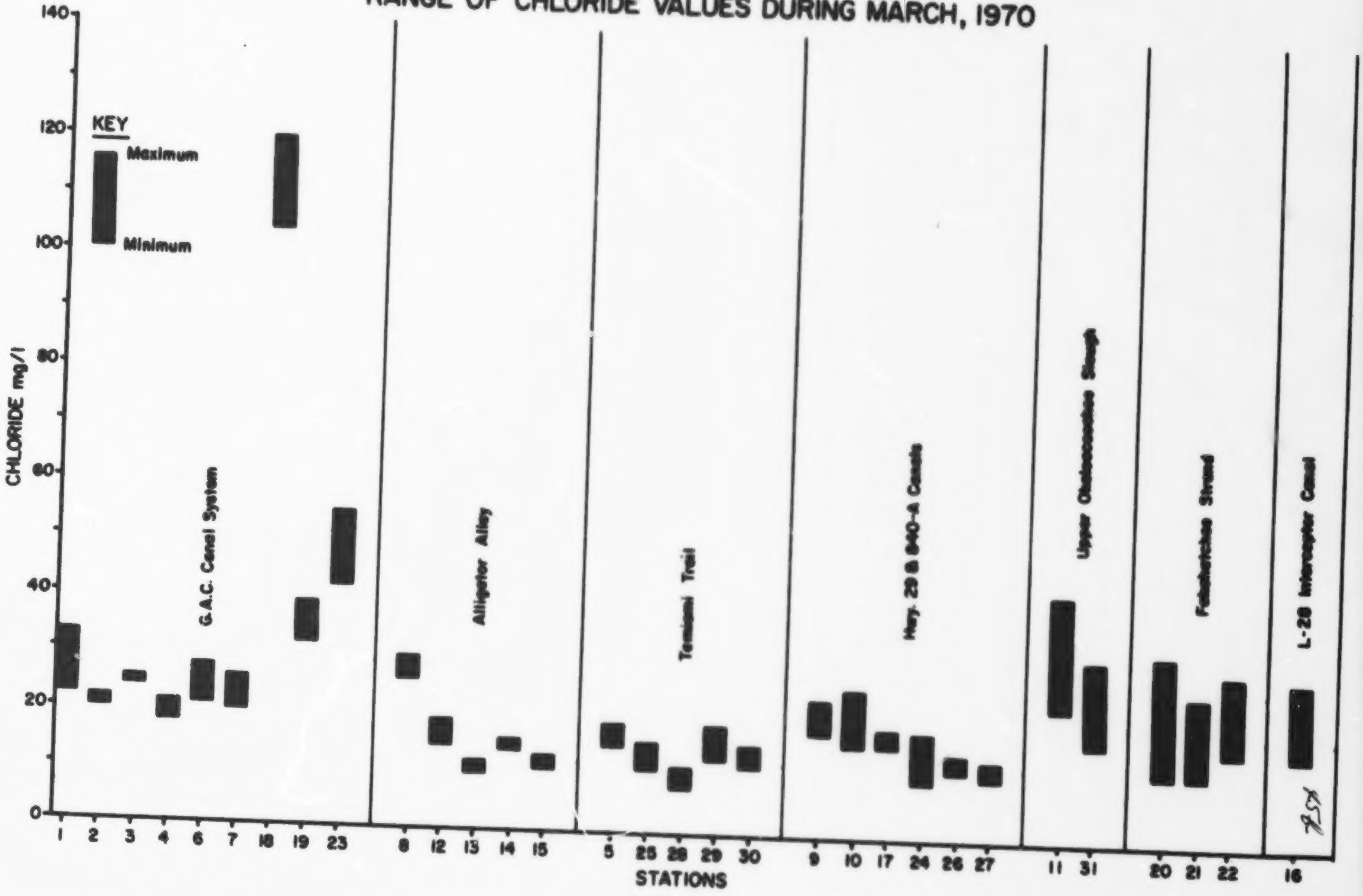


FIGURE 15

RANGE OF CHLORIDE VALUES DURING MARCH, 1970



reflected the presence of the excess chloride. Since high chlorides were reported (3) to be present in certain parts of the shallow water aquifer in Collier County, it was felt that the canal at Station 18 must intercept one of these salty groundwater pockets.

Throughout most of the undisturbed sections of the Big Cypress, chloride concentrations were generally less than 30 mg/l. Associated TDS concentrations were usually less than 250 mg/l.

Nitrogen and Phosphorus - Levels of nitrogen (N) and phosphate (P) in waters are indicators of the enrichment level of such waters. High levels can sometimes be related to man's acceleration of natural eutrophication processes. The N and P levels in the Big Cypress (reported in the forms of organic-N, nitrate-N, ammonia-N, and total and dissolved phosphate as P) were low in most areas. Figures 16, 17, and 18 show nitrogen and phosphorus variations and mean values.

With few exceptions, the organic nitrogen content was consistent throughout the study area, generally averaging between 0.5 and 1.0 mg/l. At Stations 1, 18, 15, 19 and 17, organic nitrogen concentrations averaged 0.1 mg/l or less. The general lack of biological activity at Stations 18 and 19 (new canals) could account for the low organic-N at these sites and the mechanical removal of hyacinths from Station 1 could account for a portion of the reduction there, but no feasible explanation could be found for low values at Stations 15 and 17.

Nitrate, a readily assimilable nitrogen form, was found consistently less than detectable limits, i.e. 0.05 mg/l as N, throughout much of the Big Cypress study area. Maximum nitrate concentrations (Table G-I) were highest in the upper GAC canals and in L-28 Interceptor Canal (Station 16).

FIGURE 16

THE MEAN & RANGE VALUES FOR ORGANIC NITROGEN DURING MARCH, 1970

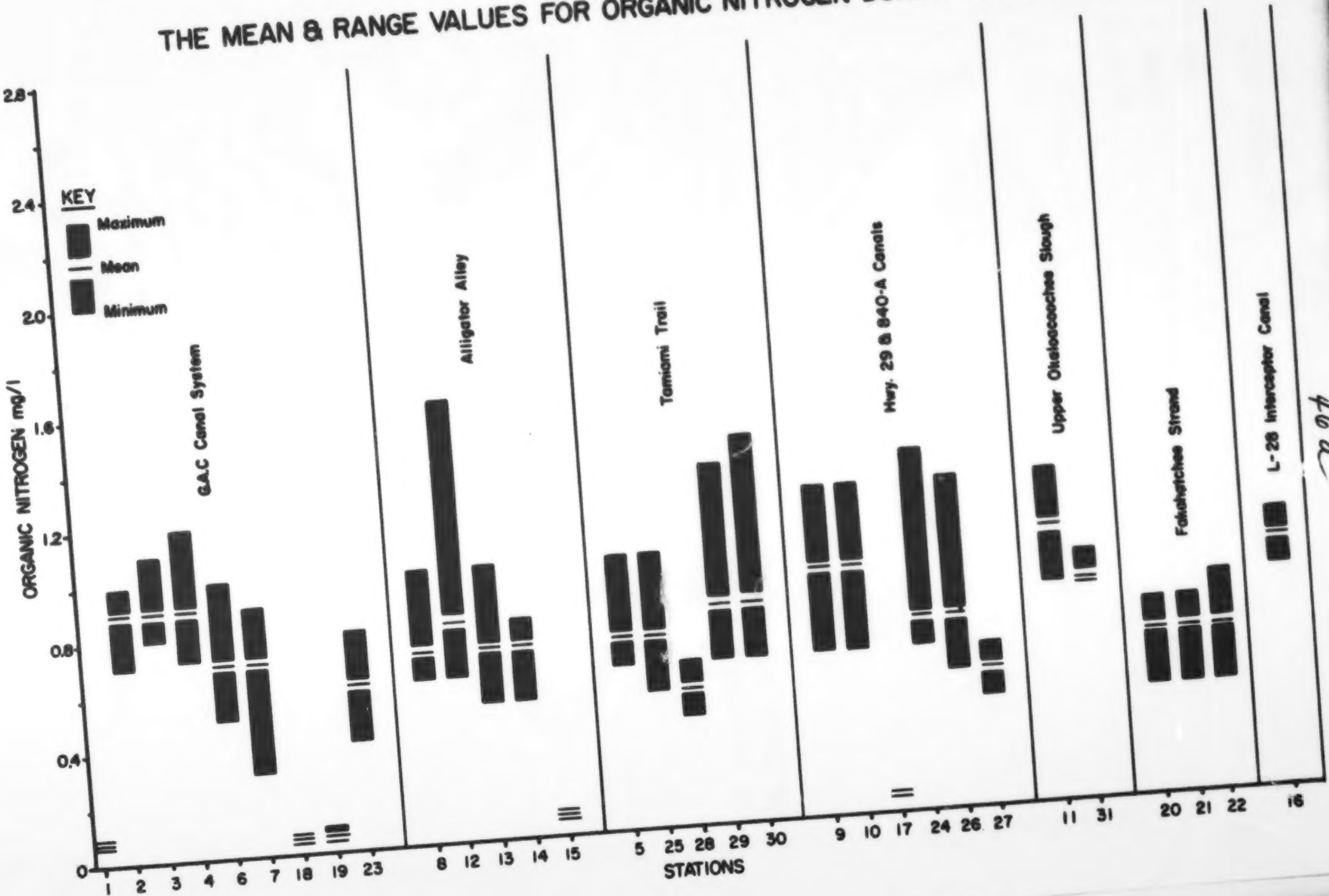


FIGURE 17

THE MEAN & RANGE VALUES FOR AMMONIA DURING MARCH, 1970

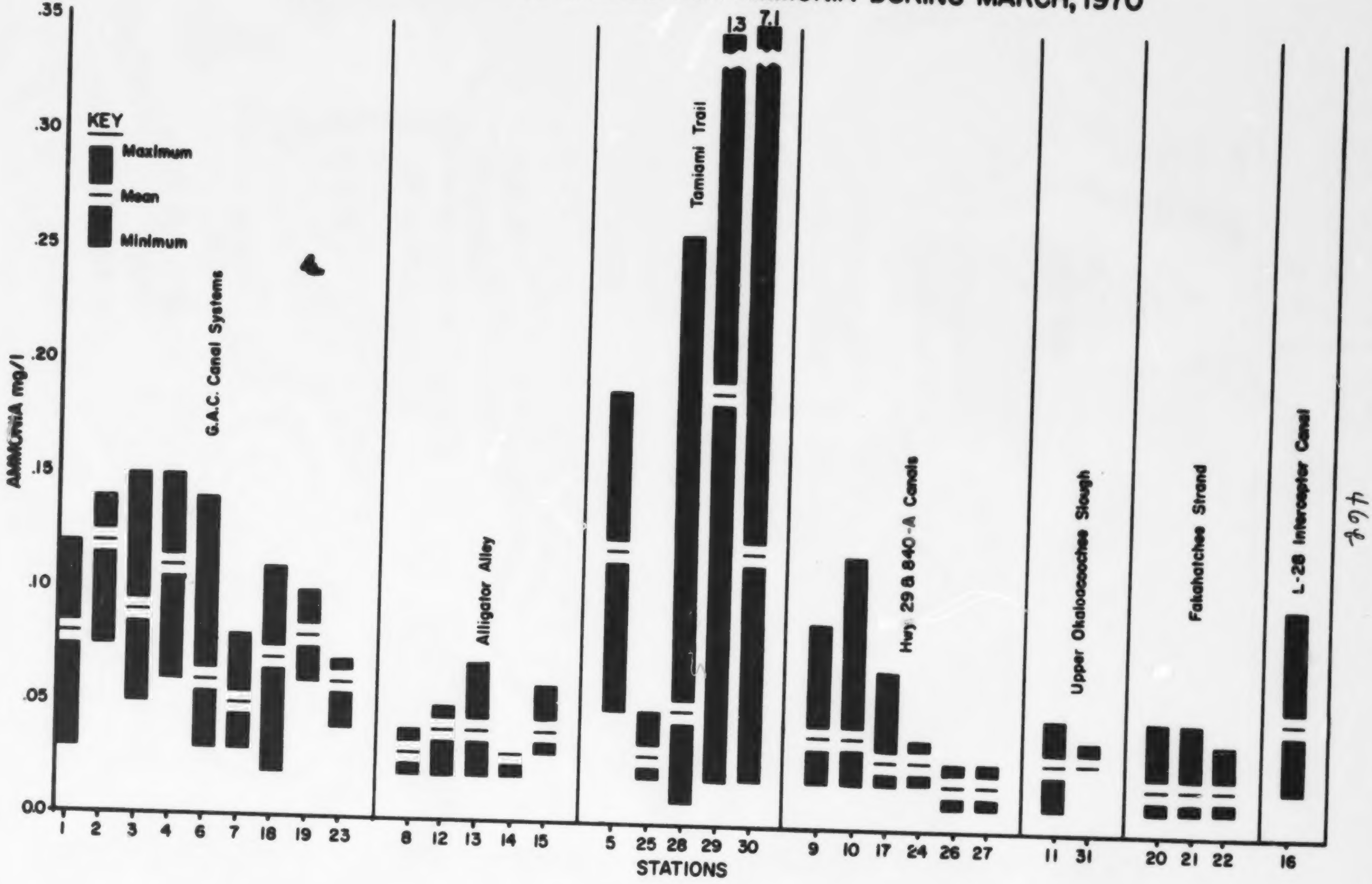
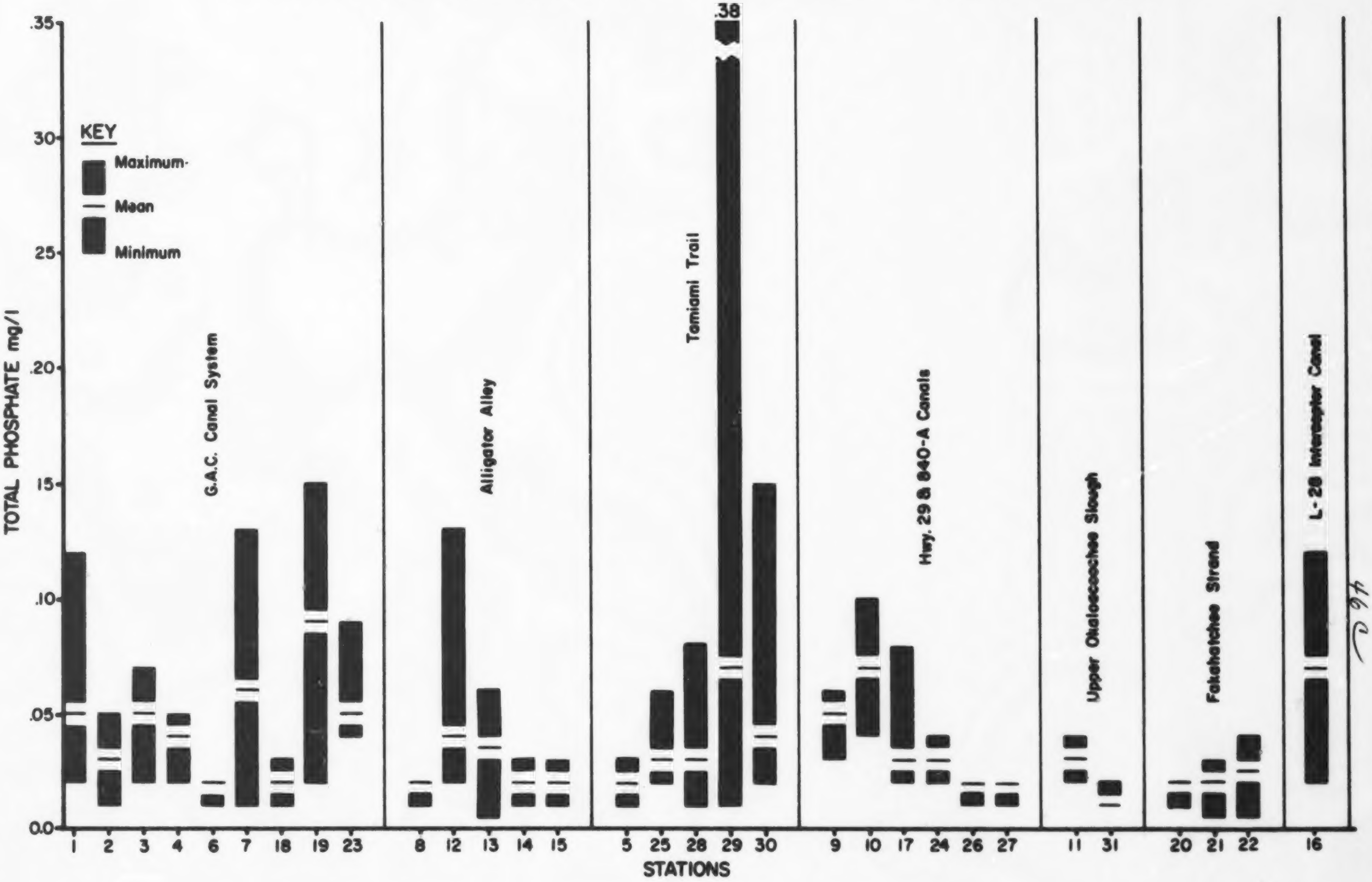


FIGURE 18

THE MEAN & RANGE VALUES FOR TOTAL PHOSPHATE DURING MARCH, 1970



Major sources of ammonia include organic decomposition and animal wastes. It is interesting to note that the highest ammonia concentrations in the Big Cypress were at three stations along the Tamiami Trail (Stations 28, 29, and 30) where birds and other wildlife were abundant and aquatic plants were profuse. Maximum ammonia concentration at these three stations (Figure 17) ranged from 0.26 to 1.3 mg/l. Elsewhere in the Swamp, ammonia was generally present in concentrations less than 0.15 mg/l. Average ammonia concentrations were highest at Stations 29 and 30 and in the GAC canals.

The phosphate content of Swamp waters was affected by three principal sources: (a) phosphate content of marl which exists in some areas and is exposed through canal construction, (b) fertilizers used in the agricultural areas, and (c) wastes from the animal population. To determine the extent to which each of these sources contributes to the phosphate concentrations observed was considered beyond the scope of the March study. It is thought, however, that the maximum total phosphate concentrations found in some areas, e.g. Stations 12, 29 and 30 (Figure 18), were related directly to animal populations in these areas. Stations 7 and 19, which had relatively high averages for total P, represented upstream and downstream points in a new GAC canal which exposed marl deposits and which drained from an agricultural region.

Total phosphate averaged 0.05 mg/l or less at most sampling stations. Such concentrations are thought to be below levels capable of producing nuisance aquatic growths.(8) The more assimilable dissolved P forms were found commonly throughout the Big Cypress at levels less than 0.04 mg/l. Concentrations higher than this, as high as 0.16 mg/l, were associated with the same stations having the highest total P values.

In summation, the overall nitrogen and phosphorus nutrient quality of Big Cypress waters during the month of March indicated no overenrichment problems caused by man's influence. Effects of natural animal populations were evident. With seasonal studies, better definition of nutrient relationships and sources would be possible. Appreciable amounts of N and P are known to be utilized by and bound up in the abundant rooted, floating, and attached plant forms found in many areas of the Swamp.

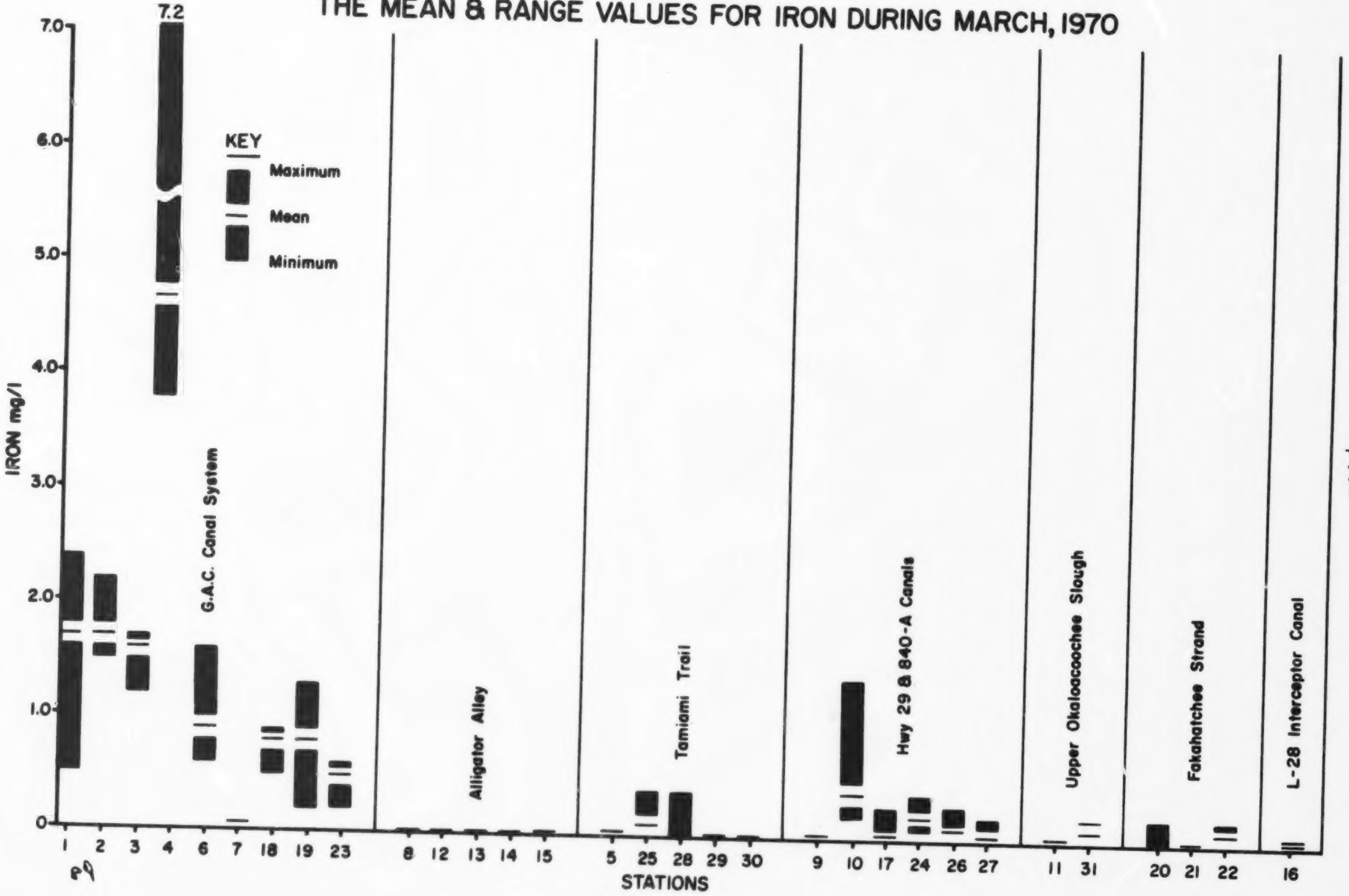
Copper, Iron, and Manganese - Atomic absorption analysis of daily grab samples for total copper, iron, and manganese content are summarized in Table C-I. These three metals are included in fungicides applied in agricultural sections of the study area. Spectrographic analysis of composite samples, the results of which are discussed in a later section, also included copper, iron, and manganese. The two sets of results obtained using the different analytical techniques tended to corroborate each other.

Copper concentrations were below 0.01 mg/l (the detection limit) at all stations. Manganese levels were low also, frequently less than the detection limit of 0.02 mg/l. Public Health Service Drinking Water Standards (9) recommend dissolved manganese levels equal to or less than 0.05 mg/l.

The results of iron analyses shown in Figure 19 reflect the same general findings discussed in greater detail in the Spectrographic Analyses section.

Total Organic Carbon - Carbon is one essential metabolic elements required by plants and animals, yet excessive amounts in water can cause

FIGURE 19
THE MEAN & RANGE VALUES FOR IRON DURING MARCH, 1970



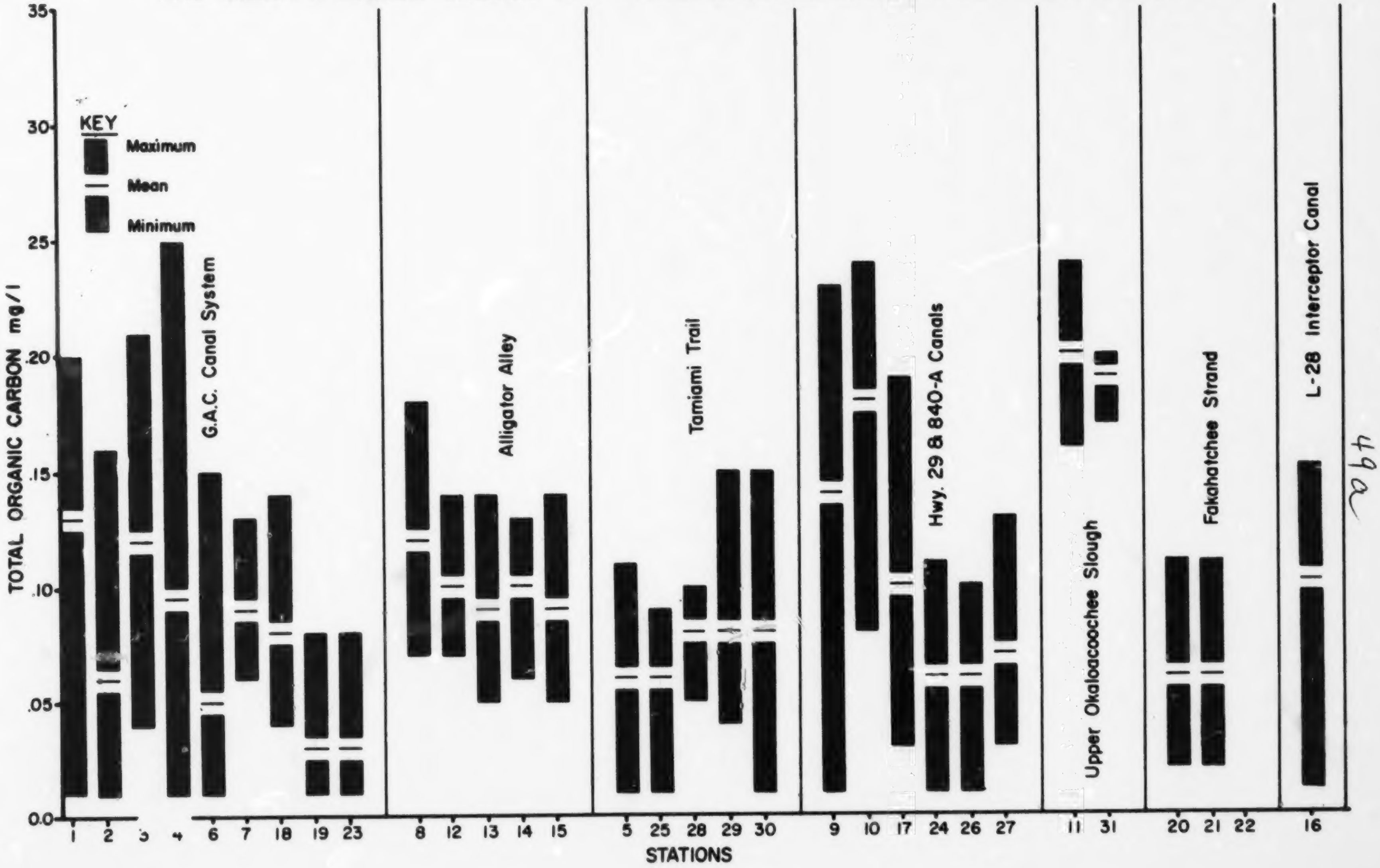
pollution problems. Study area waters were examined for total organic carbon (TOC) content in order to determine if appreciable differences existed between developed and undeveloped areas (Figure 20). In the GAC canal system, the highest average TOC value, 13 mg/l, was found at Station 1. This station had very high phytoplankton counts and was located downstream from the Golden Gate subdivision and waste treatment plant. Average values over the study area ranged from a low of 3 mg/l (Stations 19 and 23) to 20 mg/l (Station 11). The latter value was found in a livestock grazing area. The highest maximum TOC value of 25 mg/l came from a Station 4 sample.

The TOC data collected will be utilized for background information, especially in areas now undergoing development. The developed areas again showed differences in quality when compared to undisturbed portions of the Swamp. Although the organic carbon input to the Big Cypress ecosystem does not appear to be a problem at this time, increased urban, agricultural, industrial, or other development could effect water quality damage and altered ecology.

Pesticide Residue and General Organic Quality - With the use of advanced gas chromatographic and infrared spectroscopic techniques available at the Southeast Water Laboratory, samples from Stations 1 through 31 were analyzed for presence of organochlorine and organophosphate pesticides and for general organic quality. The results of these analyses are not necessarily representative of pesticide and general organic quality on a year-round basis. Only one grab sample per station was obtained and this, of course, only during the March study period. A more definitive study of

FIGURE 20

THE MEAN & RANGE VALUES FOR TOTAL ORGANIC CARBON DURING MARCH, 1970



pesticide levels and organic quality of Big Cypress waters would include more frequent sampling over a year or more period for not only the water fraction but also associated sediment, plant, and animal life. Such a study was considered beyond the scope of the work reported here.

The pesticides analyzed for and their minimum detection limits are listed in Table V . Even though sampling was minimal, the consistent absence of detectable pesticides at all but two stations suggests a general lack of pesticide contamination at the present time. At Station 1 trace quantities of DDT and DDE were present, 0.03 and 0.01 µg/l respectively. These are not concentrations to cause concern. However, the fact that these pesticides were found in the area of greatest land development (downstream from Golden Gate subdivision) suggests what increased development could produce in the Swamp itself. A concentration of 0.04 µg/l DDT at Station 9 was the only other pesticide detection reported. This station was located on the Hwy 29 canal which includes drainage from the Immokalee, Florida area.

General organic analyses produced no organics of significance by either gas chromatographic (flame ionization detector) or infrared spectroscopic (potassium bromide pellet) techniques. This indicates the absence of phenols or hydrocarbons from fuels in microgram per liter or higher concentrations in the samples. Again, the samples may not have been representative of quality at all times.

TABLE V

PESTICIDE ANALYSES AND MINIMUM DETECTION LIMITS

PESTICIDE	MINIMUM DETECTION LIMIT (μg/1)
DDT	0.02
DDE	0.01
DDD	0.01
Dieldrin	0.01
Endrin	0.02
Methoxychlor	0.05
Chlorobenzilate	0.4
Lindane	0.005
BHC	0.005
Heptachlor	0.005
Heptachlor epoxide	0.01
Aldrin	0.005
Toxaphene	0.4
Chlordane	0.04
Diazinon	0.2
Methyl parathion	0.01
Malathion	0.2
Parathion	0.02
Ethion	0.05
Trithion	0.05
Guthion	0.5

Spectrographic Analyses - Samples from Stations 1 through 30 were subjected to spectrographic examination for 18 trace metals. These samples were composites made from daily collections during the last two weeks in March. The 18 trace metals are listed in Table VI. Three of these metals- iron, copper, and manganese- were also determined on a daily basis throughout the month. The reason for more extensive study of these three metals was to determine if agricultural application of the fungicides containing iron (Ferbam), copper, and manganese (Maneb) was causing contamination of Big Cypress waters.

Appendix C contains the complete spectrographic analysis results. A summary of these results is presented in Table VI. Results are expressed as μg/l and represent the total sample, dissolved plus suspended.

Boron, iron, barium and strontium were observed at measurable levels in all samples. Zinc, manganese, aluminum, lead and chromium were detected in 70 percent or more of the samples. Beryllium, nickel, cobalt and vanadium occurred with a frequency of between 33 and 50 percent. Cadmium was observed in one sample at 14 μg/l. Arsenic, molybdenum, copper and silver were either all absent, or below the detection limits in all samples.

Iron concentrations were quite large in several samples, ranging as high as 8 mg/l at Station 4. High levels of aluminum were also recorded in several samples. The frequency with which beryllium, nickel, cobalt, lead, chromium and vanadium were observed exceeds that generally observed in the United States.(10) Lead values, which ranged as high as 200 μg/l in one sample, were all confirmed by atomic absorption analysis.

TABLE VI

SUMMARY OF SPECTROGRAPHIC ANALYSIS RESULTS

ELEMENT	FREQUENCY OF DETECTION, %	CONCENTRATION RANGE, μg/l
Zinc	70	<10 - 70
Cadmium	3	<10 - 14
Arsenic	0	<50
Boron	100	17 - 200
Iron	100	21 - 8000
Molybdenum	0	<20
Manganese	93	<4 - 33
Aluminum	86	<20 - 3300
Beryllium	33	<0.1 - 0.15
Copper	0	<25
Silver	0	<1.0
Nickel	40	<10 - 24
Cobalt	50	<10 - 24
Lead	73	<20 - 200
Chromium	93	<4 - 31
Vanadium	37	<20 - 40
Barium	100	5 - 27
Strontium	100	30 - 500

The GAC canal system stations had the highest iron concentrations in the Big Cypress. The 8.0 mg/l value at Station 4 was at least two times higher than concentrations found in any of the other GAC canals. Water quality at this station is also influenced more by the agricultural and GAC Corporation land clearing operations along the northern Swamp boundary. In the Hwy 29 and 840A station grouping (Stations 9, 10, 17, 24, 26 and 27), the stations along Hwy 29 (9, 10 and 24) had iron concentrations several times higher than at the other three stations. These Hwy 29 stations were more representative of agricultural runoff than the others in the group. If indeed the agricultural and/or land clearing operations in the Big Cypress area cause an iron contamination problem, and the spectrographic data suggest this, the consequences would be felt in any water supply use of the contaminated waters.

The manganese concentrations (Appendix C) followed the same patterns as iron, i.e. higher in canals draining from agricultural and land clearing areas. Copper on the other hand, which is used in agricultural fungicides, was not detected. This latter finding suggests that a more detailed study of the effect on surficial water quality of agriculture and land clearing in the Immokalee area would be needed before metal contamination could definitely be verified. The implication is strong at this point, however.

That the frequency with which beryllium, nickel, cobalt, lead, chromium, and vanadium were observed exceeds the U. S. norm is not necessarily cause for alarm. The actual concentrations of these elements, with the exception of lead, were usually less than that reported nationally.(11) Lead concentrations were high, higher actually at 18 out of 30 stations than the Public Health Service Drinking Water Standards(9) permit. It should be noted that the lead could have been and probably was present in greater proportion in the suspended solids fraction of the water samples than in the dissolved solids fraction. Suspended material, moreover, is normally removed by conventional water treatment processes. The presence of lead at concentrations as high as 200 µg/1 does, however, indicate a problem. Stations where lead levels were highest were generally those in the GAC canal system. No real pattern could be discerned, although, with the exception of the Janes Scenic Drive area, the least disturbed portions of the Swamp had the lowest lead levels.

The disproportionately high aluminum concentration at Stations 19 and 23 (3.3 and 1.6 mg/1 respectively) were related directly to canal construction activities immediately upstream from Station 19. Suspended matter from dredging operations is introduced into the waters which flow past Stations 19 and 23.

Special Hourly Variation Studies - Knowledge of diurnal changes in water quality is helpful for interpretation of grab sample analysis data. Such knowledge can also provide insight into the degree of biological activity in a given aquatic environment. The characteristics frequently chosen for diel examination are pH, CO_2, and DO. In selected areas of the Big Cypress Swamp, analyses were made at 2-hour intervals to determine the levels of these three constituents. Temperature measurements were also added. The areas selected for one-day studies were:

GAC canals (Stations 2, 3, and 4),
Fakahatchee Strand (Stations 20, 21 and 22),
Alligator Alley (Stations 12, 13 and 14), and
Tamiami Trail (Stations 28, 29 and 30).

Diurnal studies were made between the hours of 9 a.m. and 5 p.m. Weather conditions were similar during each separate day of study.

Hourly quality variations in each of the four areas are shown in Figures 21, 22, 23, and 24. The figures imply that biological activity, i.e. photosynthesis, respiration, etc., was greatest in the Fakahatchee Strand and along the Tamiami Trail. Both of these areas were observed to be rich in rooted and attached plant forms. Floating aquatic plants were also abundant along the Trail. The water quality of the GAC canals tends to repress biological activity at this time. Consequently, hourly pH, CO_2, and DO variations in the GAC canals were the lowest of the four areas.

At the Trail Stations, the DO differential was as much as 4.5 mg/l between a.m. and p.m., while along Alligator Alley the maximum differential was only 2 mg/l. Free CO_2 was depleted by late afternoon at all three Tamiami Trail stations. This represented up to a 6 mg/l CO_2 depletion between a.m. and p.m.

Although the special hourly variation studies revealed much useful information about biological activity in various sectors of the Big Cypress ecosystem, these studies were not completely conclusive. Studies during drier periods would provide additional knowledge needed to understand the Big Cypress ecosystem.

FIGURE 21

HOURLY QUALITY VARIATION IN G.A.C. CANAL SYSTEM (MARCH 19,1970)

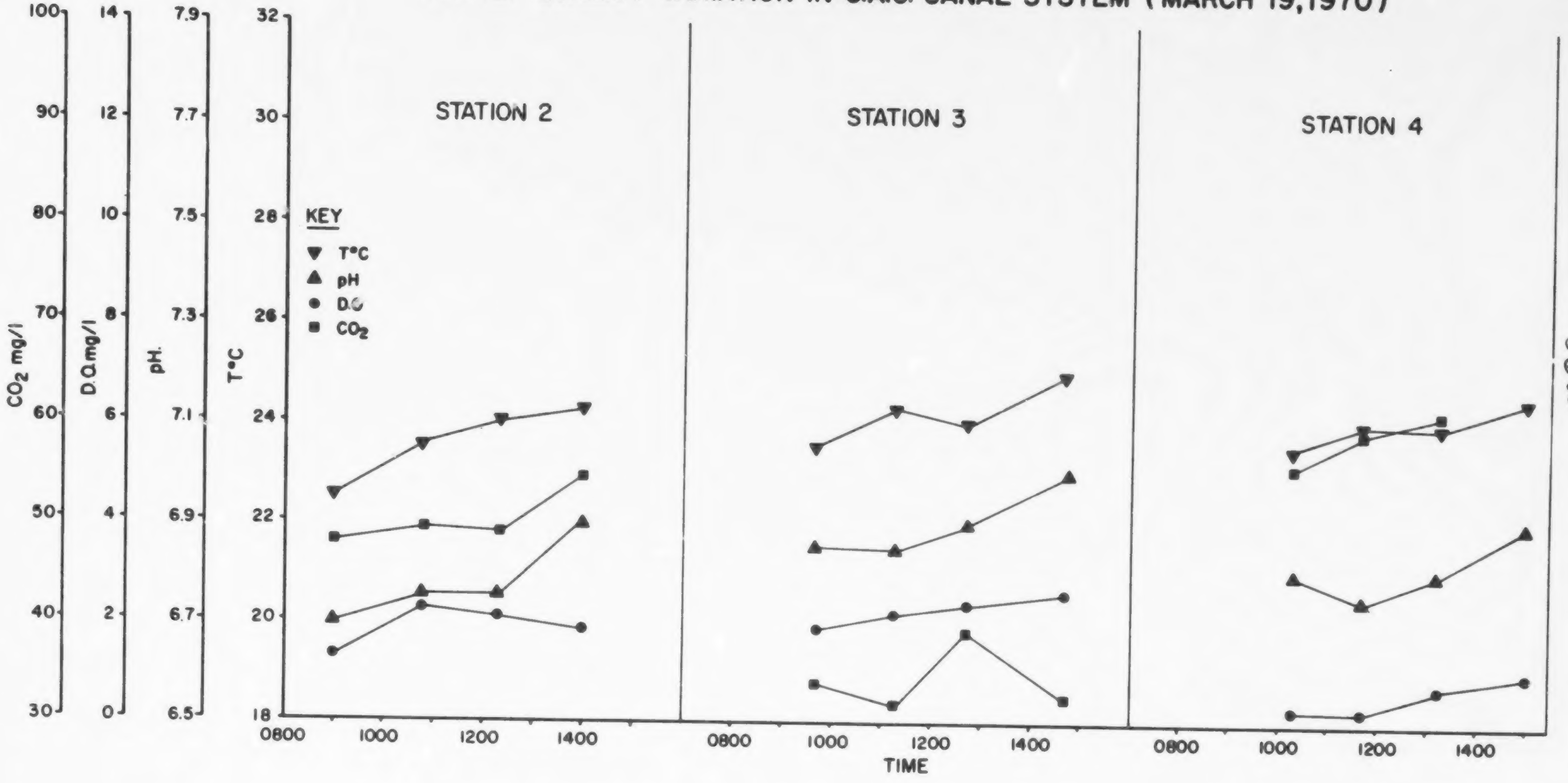


FIGURE 22
HOURLY QUALITY VARIATION IN FAKAHATCHEE STRAND (MARCH 24, 1970)

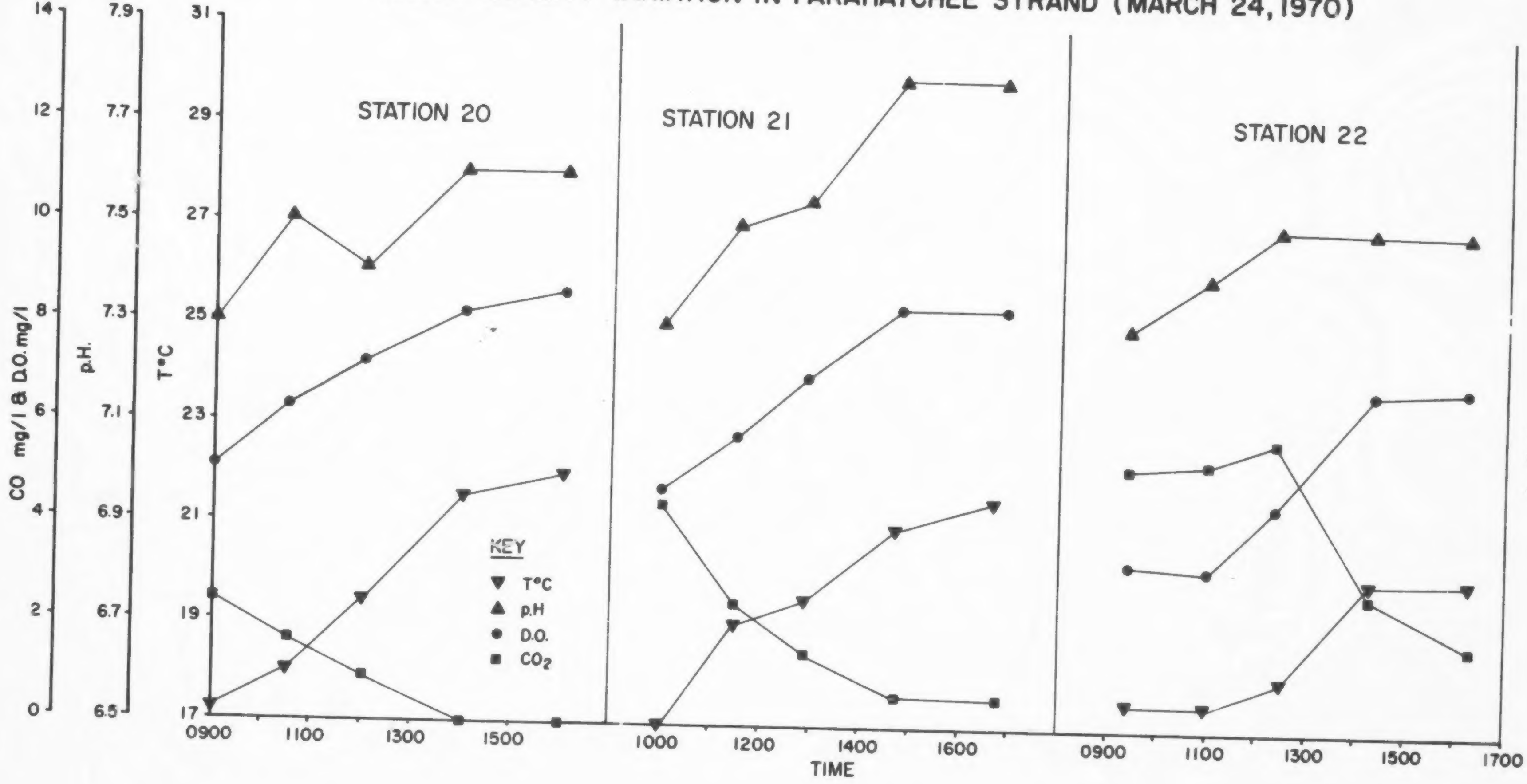


FIGURE 23

HOURLY QUALITY VARIATION IN ALLIGATOR ALLEY CANAL (MARCH 20, 1970)

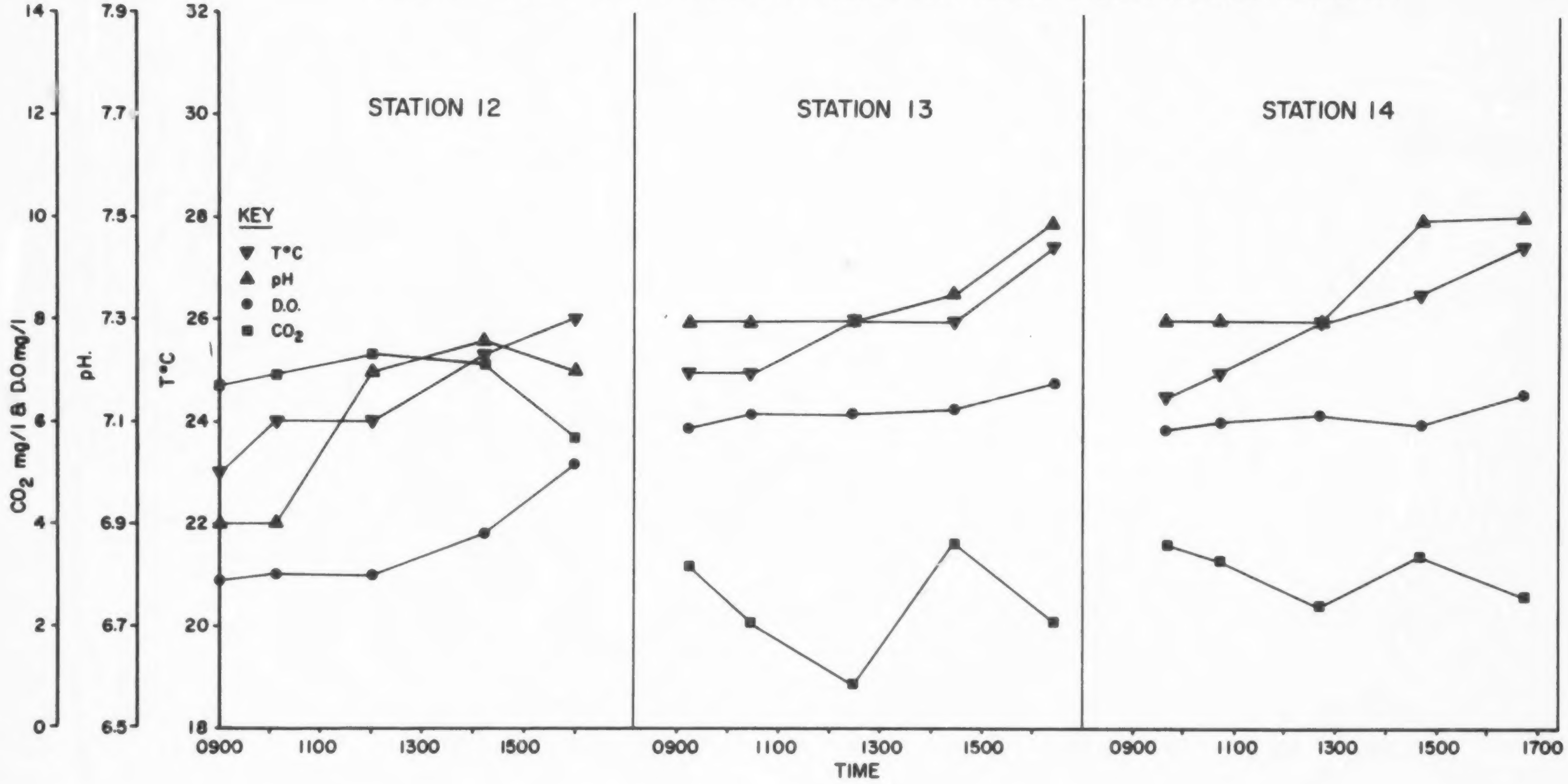
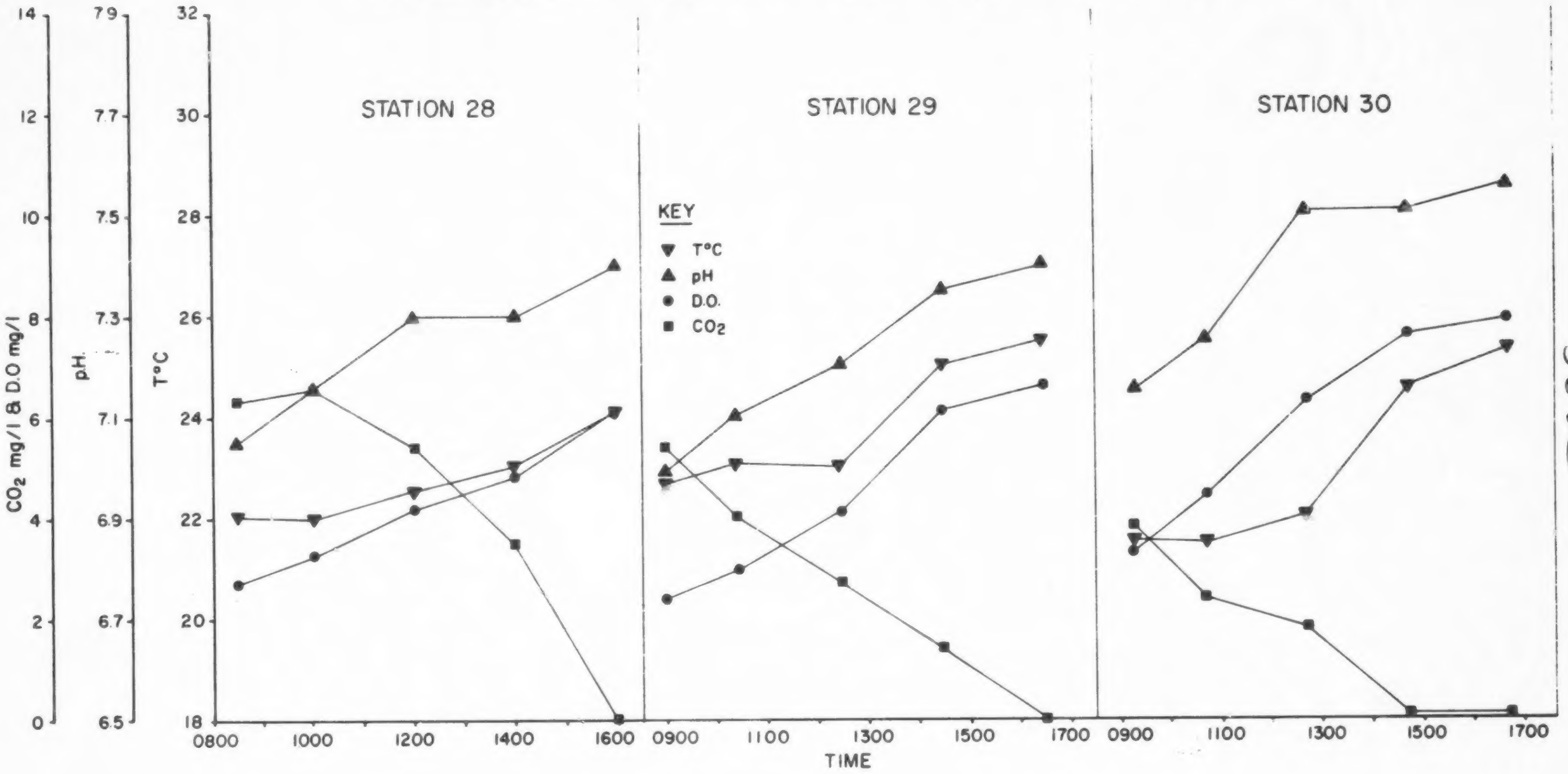


FIGURE 24

HOURLY QUALITY VARIATION IN TAMIAMI TRAIL CANAL (MARCH 23, 1970)



Biological Quality

Phytoplankton - The clear, generally shallow waters of the Big Cypress Swamp contained a phytoplankton population ranging from about two hundred to less than 3,000 cells per milliliter (Figure 25). Growth or aggregations sufficiently dense as to be readily visible were not observed; hence, plankton blooms were not recorded in March 1970.

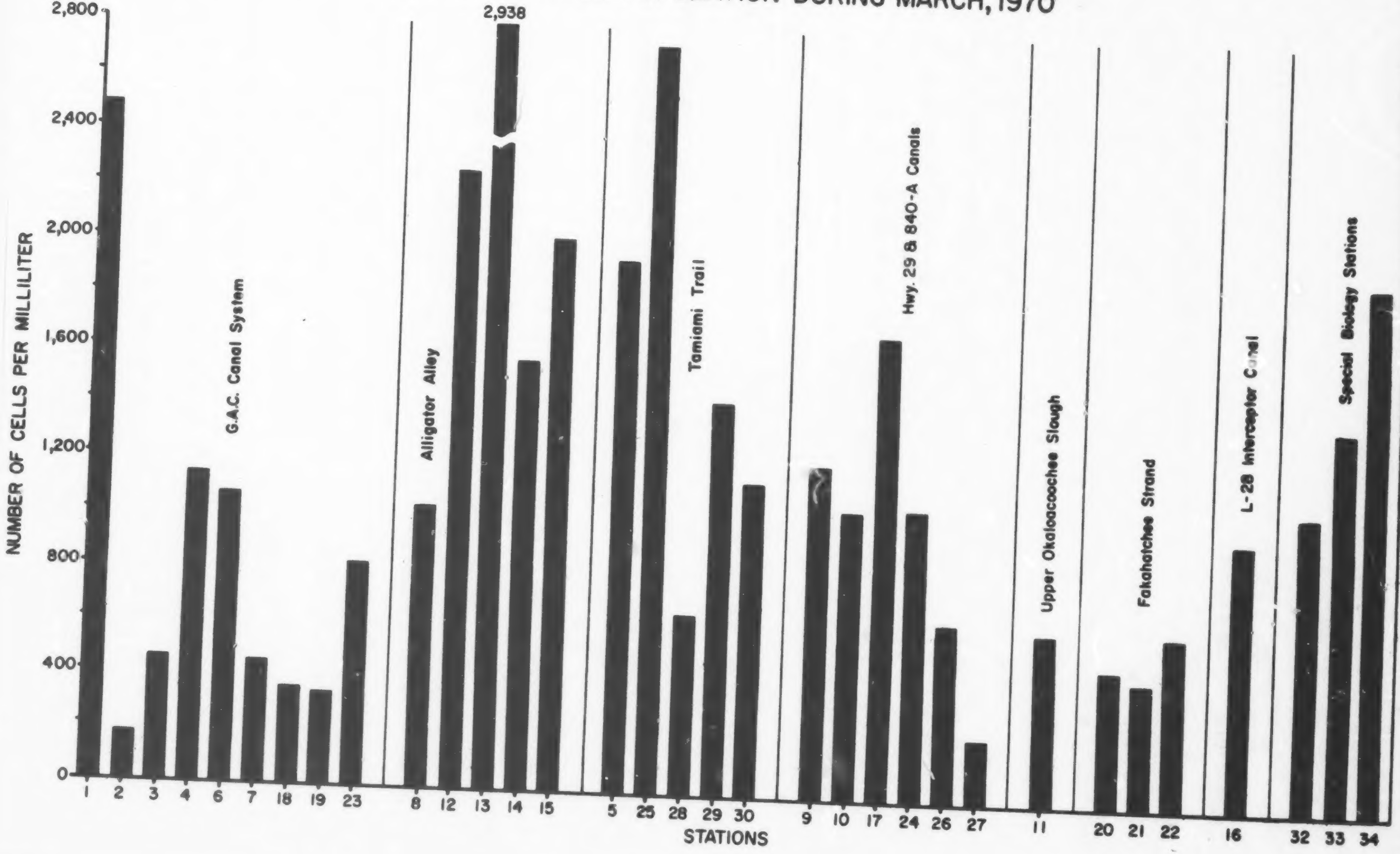
In the GAC Canal network the greatest phytoplankton population was recorded at Station 1. This station was located downstream from a sewage treatment facility. However, nutrients, such as nitrogen and phosphorus, were not significantly higher at this station than at other GAC Canal stations. It is conceivable that the higher plankton population was indirectly related to the mechanical removal of certain higher plants. Living hyacinths are removed periodically from the canal by dragline and trucked away. Nutrients normally used by these hyacinths are made available to other type plants, e.g. phytoplankton.

Phytoplankton populations for the entire study area were greatest in the Alligator Alley Canal and in the Tamiami Canal. Generally, the population in Alligator Alley Canal was higher than in the Tamiami Canal. Differences between the two areas were caused, at least in part, by the shading effect of water hyacinths. Hyacinths often completely covered the surface of the Tamiami Canal.

The low phytoplankton populations recorded in the densely wooded Fakahatchee Strand seem to support the fact that shading reduces the phytoplankton population in these natural areas. Clearing of land, then, with resultant increased exposure to sunlight, will alter the phytoplankton composition. As water temperatures increase from the additional solar heating, growth stimulation of undesirable blue-green algae will also occur.

FIGURE 25

PHYTOPLANKTON POPULATION DURING MARCH, 1970



Periphyton - Studies done by Van Meter (12) in the nearby Everglades showed that periphyton was the major source of aquatic primary production. Observations made during the FWQA study suggested that a similar trend occurred in the Big Cypress Swamp.

A comparison of the periphyton population with its respective unit weight can be made from Figures 26 and 27. Such a comparison is needed for determining biological activity. For example, a mixture of numerous diatoms in a shallow wet prairie may result in a high cellular count and still have little biomass. The converse can occur in a deep canal containing long filamentous algae. Periphyton growth over a given period of time (3 weeks for this study) is the better indicator, then, of biological activity. Figure 27 shows a three-week growth accumulation.

Periphyton growth abounded in all clear, unshaded habitats throughout the Big Cypress.

Vascular Plants - A myriad of plants exist in the Big Cypress Swamp. In the continental United States, many of these subtropical forms are restricted to southern Florida. Because the Big Cypress is considered to be aquatic rather than terrestrial, the true aquatic plants will be discussed first. Table VII contains a list of some common rooted aquatic plants found in the Swamp together with their relative distribution. Their density is generally related to the amount of sunlight available, and in the case of canals, the age of the canal. Only in the sun-exposed areas of the swamp were luxuriant growths present. This may give some indication as to what will happen in new and proposed canals because of their complete exposure to sunlight.

The problem of water hyacinths in the canals of southern Florida has been documented frequently. Observations made during this survey showed that a relatively new canal network (GAC system) is becoming weed-choked, and in some

FIGURE 26
PERIPHYTON POPULATION DURING MARCH, 1970

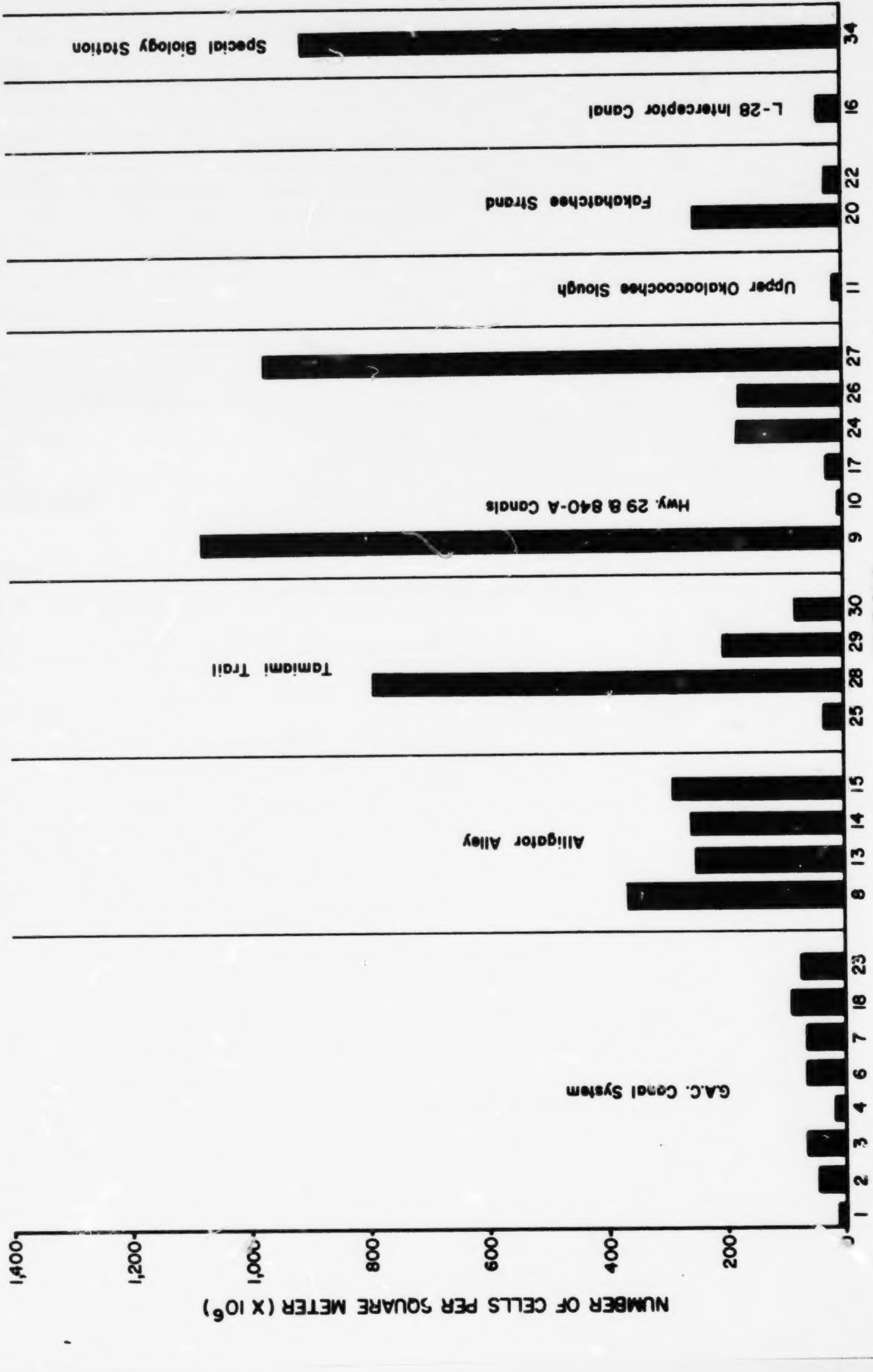


FIGURE 27

AVERAGE DRY & ASHED PERIPHYTON WEIGHTS (MARCH, 1970)

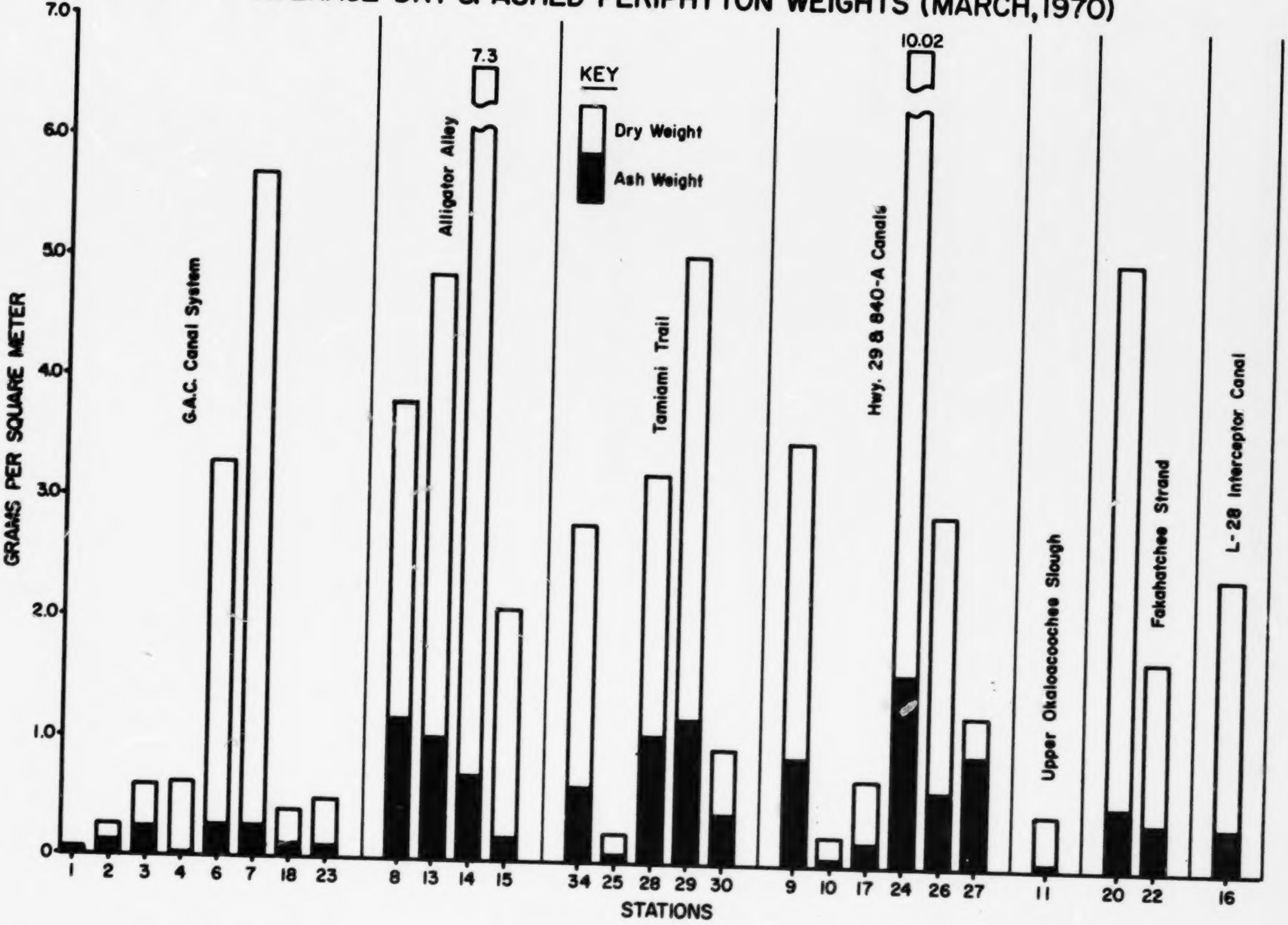


TABLE VII

COMPARATIVE DENSITY OF DOMINANT ROOTED VEGETATION BY HABITAT TYPE*

TAXA	GAC Canal System (Station 1)	GAC Canal System (Station 23)	Alligator Alley Canal (Station 14)	Tamiami Trail Canal (Station 5)	Tamiami Trail Canal (Station 29)	Hwy. 840A Canal (Station 17)	Interceptor Canal (Station 16)	Cypress Pond (Station 32)	Cypress Slough (Station 21	Sawgrass Marsh (Station 34)	Cypress Swamp (Station 28)	Wet Prairie (Station 33)
cattail	M	S	S	M		M						
Najas spp.	S	M	M		L	L	S	M	L		L	
arrowhead		S	S	S		S	S	S	S	S	S	S
panic-grass	S			S						S		L
sawgrass				S				S		L		
pickerelweed		S	S	S					S	S		
fire flag			S									
coontail					S	M						
water milfoil						M						
water hyssop			S	S		M			M	L	S	L
bladderwort		S	S	S						S		S

* Sparse (S) - less than 10% coverage

Moderate (M) - 10-40% coverage

Luxuriant (L) - over 40% coverage

areas virtually blanketed with hyacinths. Mechanical weed removal is being employed in some canals in order to prevent unsightly shoreline and surface accumulation of hyacinths and/or bottom deposits of dead plants.

The terrestrial plants observed during the study are listed in the Appendices. The presence of many of these plants are the result of man's influence on the Big Cypress ecosystem. For example, when cypress are removed for lumber or merely for clearing purposes and the land is drained, a regrowth association of shrub willow and maple develops. These trees have been left to grow in an unrestricted fashion.

The State of Florida now protects tropical air plants (bromeliads) and orchids commonly seen on bald cypress trees. These protected plants are in jeopardy because of drainage and clearing which results in the death or removal of the cypress. Presently, many cypress are dying in the western portion of the Swamp because of the extensive land development projects of the GAC Corporation.

Invertebrates - The diverse and abundant population of aquatic invertebrates in the Big Cypress Swamp reflected a healthy environment during March 1970. Table VIII compares the standing crop of certain benthic groups and lists their distribution. The habitats listed may not be preferred by these organisms, but may be the only aquatic habitat available. This is especially true in the western portion of the Big Cypress area where drainage canals have become the only continuously wet areas.

Drainage canals could influence the total ecobalance of the Big Cypress Swamp and the dependent sections of Everglades National Park. Chemical data collected showed that groundwater seepage into canals has changed water quality. Seepage at Station 18, for example, appeared to be responsible for increased chloride concentrations (104 to 120 mg/l during March).

TABLE VIII

COMPARATIVE DENSITY OF DOMINANT BENTHOS BY HABITAT TYPE (NUMBER PER M^2)

TAXA	GAC Canal System (Station 1)	GAC Canal System (Station 23)	Alligator Alley Canal (Station 14)	Tamiami Trail Canal (Station 5)	Tamiami Trail Canal (Station 29)	Hwy. 840A Canal (Station 17)	Interceptor Canal (Station 16)	Cypress Pond (Station 32)	Cypress Slough (Station 21)	Sawgrass Marsh (Station 34)	Cypress Swamp (Station 28)	Wet Prairie (Station 33)
Oligochaetes	43	20	23	211	189	76	144	70	53		265	370
leeches				34	106	83				8	247	
Amphipods	3	15	8	27	672	61			1886	68		8
water mites	3	3		30	60	23	3	6	295		181	15
Caenis diminuta	20	149		246	211		129		2462	15	83	8
dragonfly nymphs	1	23	4	12		39	11		15		30	
damselfly nymphs		136		7		15	8		136		75	
caddisfly larvae	3	28		17		279	67		189			
beetles					8				15			
Tanypodinae	8	83	65	250	31	53	3	51	55	15	409	45
Polypedilum spp.	5			254	30		547		8		23	8
Chironomus spp.		8	680	117	2960	778	91	57	76	23	477	990
Tanytarsini		18	113	431	401	233			190		38	114
Ceratopogonidae	10	116	46	5		127	74		423		181	174
snails	29	3	15		91	99	30	27		23	30	8
clams	25			79		182	20		53			

If the chloride concentration continued to increase, the environment in this canal could become brackish and many biotic changes would result. Another ecological change associated with drainage projects is the population reduction of a freshwater snail (Pomacea) which is the sole food for the Everglades Kite(13). With the reduction of this food source, the Kite has become a rare and endangered species.

Fish - Observations indicated that fishing in the canals throughout the Big Cypress study area was excellent. However, the fish community in the canals would be adversely affected if adjacent shallow wetlands (prairies and marshes) were not flooded periodically. It is within these shallows that many fish spawn and the fry find sufficient food and shelter to grow to a size capable of competing in the canals. Loss of the marshes and wet prairies will mean overcrowding in canals and may eventually be reflected in damage to fishing.

Many canals have a profuse population of garfish. These fish survive the low DO concentrations that occur during the summer and are seldom found during the periodic fish kills which occur in the canals naturally. The garfish remain in the canal because their feeding habits are not adapted to the slow-moving waters of the Swamp. Sensitive sunfish are not all killed by the low oxygen content of some canals. Many survive by finding areas with sufficient oxygen during the critical period,and they have established a large population in the canal network.

A list of the fish observed during the March 1970 survey is presented in the Appendices.

Birds - The largest bird population observed during this survey was concentrated in the southern portion of the Big Cypress Swamp near Stations 28 and 29. The rookery in the area was dominated by gregarious herons. An annotated list of birds sighted during this study is presented in the Appendix.

Many of the birds observed are dependent upon the aquatic ecosystem of southern Florida for survival. Land reclamation activities are beginning to change portions of the Swamp from wetland to dry. The impact on birdlife can be seen by comparing relative populations near the GAC development with those in the Big Cypress wilderness.

The U. S. Fish and Wildlife Service(14) has prepared a list of rare and endangered wildlife species. Among the list are 12 birds found in the Big Cypress Swamp. The Leopold Report(1) discusses the plight of each of these birds, as well as several mammals, amphibians and reptiles in danger of extinction.

General - The biotic components discussed in this section are generally part of a delicate food chain sequence: plants - invertebrates - fish - birds - etc. If the food chain is altered, the ecosystem becomes unbalanced and certain forms are threatened by extinction. Development of the Big Cypress Swamp for man's use will break this chain and will inevitably destroy the south Florida ecosystem.

Bacteria - A summary of the bacterial data is shown in Table IX. An examination of these data reveals that most of the stations had rather high total coliform densities. In comparing groupings, the highest total coliform densities were measured at Alligator Alley, followed respectively by the Tamiami Trail, the Highway 29 and 840A canals, Upper Okaloacoochee Slough, Fakahatchee Strand, the L-28 Interceptor Canal, and in the GAC canal system.

A comparison of mean[1/] total coliform densities encountered at the stations located within the GAC canal network versus stations located in all other

---

[1/] Means for bacterial data and only bacterial data are geometric means.

TABLE IX

GEOMETRIC MEAN BACTERIAL DENSITIES

STATION NUMBER	TOTAL COLIFORM per 100ml	FECAL COLIFORM per 100 ml	TOTAL PLATE count per ml
1	22,100	52	3500
2	12,000	19	2000
3	27,100	42	4000
4	23,900	19	1900
5	14,600	11	2300
6	17,800	14	1200
7	22,200	39	3000
8	11,100	23	2000
9	16,200	71	3500
10	18,700	100	4100
11	18,600	32	4500
12	33,400	41	3400
13	34,400	54	2400
14	16,200	29	3300
15	33,700	46	3600
16	7,700	17	2500
17	16,700	41	4900
18	13,800	9.2	3400
19	4,600	8.1	2300
20	20,900	140	2900
21	7,000	47	2700
22	20,100	120	2400
23	10,400	52	2900
24	17,700	95	2700
25	17,400	170	2700
26	11,700	53	7000
27	24,700	68	8200
28	30,300	81	3000
29	36,000	34	3700
30	25,000	86	3700
31	15,700	7.2	3300

areas shows that the less developed areas had higher total coliform densities (Table X). In the GAC area, 89 percent of the stations had geometric mean total coliform densities greater than 10,000/100 ml; whereas, 99 percent of the stations in all other areas had mean densities greater than 10,000/100 ml (Table X). None of the stations in the GAC area had mean total coliform densities greater than 30,000/100 ml; whereas, 23 percent of those stations located in all other areas had mean densities greater than 30,000/100 ml.

A summary of fecal coliform densities at the individual stations is shown in Table IX. These densities were lower than would be expected where an abundant animal population exists. By station groupings, the highest FC densities were measured in the Fakahatchee Strand followed respectively by Janes Scenic Drive, Tamiami Trail, Highway 29-840A canals, Alligator Alley, GAC canal system, Upper Okaloacoochee Slough, and the L-28 Interceptor Canal.

The extremely high ratios of total to fecal coliform (FC) would tend to suggest that a relatively unpolluted situation existed within the study area during March 1970.

As was the case with the total coliform, FC densities were in general slightly higher in the less developed areas than in the GAC area. A comparison of the percentage of stations at different geometric mean FC densities is shown in Table XI. As shown, 23 percent of the stations in the GAC area had mean FC densities greater than 50/100 ml, while 50 percent of the stations located in the other areas had mean densities in excess of 50/100 ml. None of the GAC stations had mean FC densities in excess of 100/100 ml, while 5 percent of the stations in the less developed area had mean densities in excess of 150/100 ml.

Although the FC densities encountered in the study area were low during March they did suggest that the less developed areas were affected

TABLE X

A COMPARISON OF GEOMETRIC MEAN TOTAL COLIFORM LEVELS

MEAN DENSITY LEVEL (per 100ml)	GAC CANAL SYSTEM	ALL OTHER BIG CYPRESS STATIONS
	% greater than or equal to	% greater than or equal to
10,000	89	99
20,000	45	46
30,000	0	23
40,000	0	0

TABLE XI

A COMPARISON OF GEOMETRIC MEAN FECAL COLIFORM LEVELS

MEAN DENSITY LEVEL (per 100ml)	GAC CANAL SYSTEM	ALL OTHER BIG CYPRESS STATIONS
	% greater than or equal to	% greater than or equal to
50	23.0	50.0
100	0.0	14.0
150	0.0	5.0
200	0.0	0.0

more by an abundant animal population. Eventually, with increased population in the developing area, a shift in the indicator pattern will almost certainly occur.

Unusually heavy rainfall during the study period was reflected in the day-to-day fluctuations in bacterial densities (Figures C-1 through C-21). Generally successive rainfalls were characterized by decreasing bacterial densities, demonstrating what appeared to be a dilution effect.

Results of total plate counts are shown in Table IX. Total plate count determinations were made to establish background information on bacterial activity in different Big Cypress areas. The total plate counts at all stations were surprisingly low. It is not known whether the low densities measured were natural or were caused by the limitations inherent in the enumerative procedure. An examination of the total count data showed that stations located within the less developed areas generally had higher mean densities (Table XII).

Presently, there do not appear to be any bacterial problems of significance in the Big Cypress Swamp. One can but speculate about future problems, however, since some areas exist where problems could arise. As urban development increases in those regions already being constructed for occupancy (principally the GAC Corporation lands), there are certain to be noticeable effects produced within the canal networks draining these areas. Some of the future problems will be a result of stormwater runoff. Characteristically, urban stormwater runoff contains significant numbers of bacterial indicators of fecal contamination together with possible pathogenic microorganisms. The introduction of these microorganisms into the canal system could create possible health-related problems associated with water contact activities.

TABLE XII

A COMPARISON OF GEOMETRIC MEAN TOTAL PLATE COUNTS

MEAN DENSITY LEVEL (per 100ml)	GAC CANAL SYSTEM	ALL OTHER BIG CYPRESS STATIONS
	% greater than or equal to	% greater than or equal to
100,000	100	100
200,000	78	100
300,000	33	59
400,000	11	22
500,000	0	10
600,000	0	10
700,000	0	10
800,000	0	5
900,000	0	0

Special attention must be given to future waste treatment facilities for these developing areas. A high degree treatment (including effluent chlorination) of domestic waste must be achieved. Because of the presence of the important shallow groundwater aquifer in the area, use of septic tanks for waste treatment must be allowed. Since recharge of the aquifer occurs in this area, this important groundwater source could become contaminated with pathogenic bacteria, viruses, nutrients, and toxic chemicals used in landscape management.

Other areas in the Swamp likely to have future bacterial problems are those areas directly affected by livestock grazing. Development of additional grazing lands and increased cattle population might well create significant problems in localized areas.

DETAILED DATA ON BIOLOGICAL CONDITIONS BY STATION GROUPS

Sampling sites in the Big Cypress Swamp have been arranged into logical groups according to characteristic similarities, e.g. hydrological, ecological and geographical. These groups are:

(A) GAC Corporation canal system - Stations 1, 2, 3, 4, 6, 7, 18, 19, and 23.

(B) Alligator Alley - Stations 8, 12, 13, 14, and 15.

(C) Tamiami Trail - Stations 5, 25, 28, 29, and 30.

(D) Highway 29 (Barron River) and 840A canals - Stations 9, 10, 17, 24, 26, and 27.

(E) L-28 Interceptor Canal - Station 16.

(F) Upper Okaloacoochee Slough - Stations 11 and 31.

(G) Fakahatchee Strand (Janes Scenic Drive) - Stations 20, 21, and 22.

(H) Special Biological Study Areas - Stations 32 (cypress pond), 33 (wet prairie), and 34 (sawgrass marsh).

A detailed discussion of aquatic biota (including bacterial types) in each of these station groups follows. Periphyton and plankton examination data referred to are presented in Tables XIII, XIV, and XV ; bacterial data in Table IX; and other biodata in the Appendices.

GAC Corporation Canal System

More than 100 miles of canals have been excavated through the soils and Tamiami limestone formation in the GAC Corporation land area. Although the width and the depth of the canals vary with their use, i.e.

TABLE XIII

PERIPHYTON POPULATION FROM SELECTED STATIONS IN THE BIG CYPRESS SWAMP

SAMPLE LOCATION		ALGAE (CELLS/M^2 X 10^6)									INERT DIATOM SHELLS	
		TOTAL ALGAE	BLUE GREEN		GREEN		FLAGELLATES (pigmented)		DIATOMS			
Station No.	Depth (in meters)		Coccoid	Filamentous	Coccoid	Filamentous	Green	Other	Centric	Pennate	Centric	Pennate
1	0.3	14	1	1	0	5	0	2	0	5	0	1
2	0.3	43	0	3	2	3	1	0	0	34	0	7
3	0.3	64	0	34	2	8	1	0	0	19	0	3
4	0.3	19	0	11	2	1	3	0	0	2	1	3
6	0.3	56	1	0	5	1	14	1	2	32	1	42
7	0.3	65	1	11	1	1	4	0	6	41	1	19
8	0.3	364	6	22	68	18	3	0	12	235	1	114
9	0.3	1076	5	124	22	5	9	0	1	910	0	72
10	0.3	9	0	0	1	0	1	2	1	4	0	1
11	0.3	15	1	4	0	0	3	0	1	6	0	1
12	0.3	54	4	1	5	8	0	0	0	36	0	42
13	0.3	254	3	53	19	9	33	2	3	132	1	57
14	0.3	258	4	21	46	7	3	0	10	167	5	70
15	0.3	282	1	12	17	10	12	3	1	220	3	62
16	0.3	38	1	6	1	8	5	1	0	16	1	3
17	0.3	27	2	1	9	2	1	0	0	12	0	11
18	0.3	87	2	3	11	1	8	1	1	60	0	21

TABLE XIII (Cont'd)

SAMPLE LOCATION		ALGAE (CELLS/M^2 X 10^6)									INERT DIATOM SHELLS	
		TOTAL ALGAE	BLUE GREEN		GREEN		FLAGELLATES (pigmented)		DIATOMS			
Station No.	Depth (in meters)		Coccoid	Filamentous	Coccoid	Filamentous	Green	Other	Centric	Pennate	Centric	Pennate
20	0.3	247	3	9	14	28	12	2	2	177	3	32
22	0.3	28	0	1	4	1	1	1	0	20	0	9
23	0.3	77	1	3	3	1	2	0	3	64	0	46
24	0.3	179	5	10	5	3	4	1	3	148	0	10
25	0.3	32	0	1	2	1	6	3	1	18	1	19
26	0.3	174	4	7	23	2	5	0	2	131	2	62
27	0.3	969	29	46	55	58	10	3	8	760	4	119
28	0.3	790	5	37	41	18	12	2	332	346	13	104
30	0.3	76	13	5	6	1	18	0	1	32	1	14
34	0.3	906	11	75	52	16	9	10	0	733	0	209

TABLE XIV

A LIST OF AVERAGE DRY AND ASHED PERIPHYTON WEIGHTS FROM SELECTED STATIONS IN THE BIG CYPRESS SWAMP, FLORIDA

STATION	DATE Submerged	Removed	SUBSTRATE	NO. OF SAMPLES	PERIPHYTON Dry (g/m^2)	WEIGHT Ash (g/m^2)
1	3-5-70	3-25-70	1x3 inch glass slides	4	0.07	0.02
2	3-5-70	3-25-70		4	0.27	0.11
3	3-5-70	3-25-70		3	0.60	0.25
4	3-5-70	3-25-70		3	0.63	0.02
6	3-5-70	3-25-70		4	3.32	0.27
7	3-5-70	3-25-70		4	5.72	0.26
8	3-5-70	3-25-70		4	3.80	1.17
9	3-5-70	3-25-70		4	3.54	0.89
10	3-5-70	3-25-70		4	0.25	0.07
11	3-5-70	3-25-70		4	0.49	0.04
13	3-5-70	3-25-70		4	4.86	1.01
14	3-5-70	3-25-70		4	7.30	0.72
15	3-5-70	3-25-70		4	2.11	0.20
16	3-5-70	3-25-70		4	2.45	0.37
17	3-5-70	3-25-70		4	0.71	0.21
18	3-4-70	3-25-70		4	0.40	0.12
20	3-4-70	3-25-70		4	5.02	0.52
22	3-4-70	3-26-70		4	1.74	0.39
23	3-4-70	3-25-70		4	0.50	0.10
24	3-4-70	3-25-70		4	10.02	1.61
25	3-4-70	3-25-70		4	0.21	0.07
26	3-4-70	3-25-70		4	2.94	0.62
27	3-4-70	3-25-70		4	1.28	0.92
28	3-4-70	3-25-70		3	3.23	1.06
29	3-4-70	3-25-70		4	5.06	1.21
30	3-4-70	3-25-70		4	0.96	0.43
34	3-4-70	3-25-70		4	2.83	0.62

TABLE XV

PHYTOPLANKTON POPULATION AT SAMPLING STATIONS IN THE BIG CYPRESS SWAMP

SAMPLE LOCATION		ALGAE (number per milliliter)									INERT DIATOM SHELLS	
		TOTAL ALGAE	BLUE GREEN		GREEN		FLAGELLATES (pigmented)		DIATOMS			
Station No.	Depth		Coccoid	Filamentous	Coccoid	Filamentous	Green	Other	Centric	Pennate	Centric	Pennate
1	Surface	2482	0	0	1270	40	437	119	40	576	0	0
2	"	179	0	0	40	40	79	0	0	20	0	79
3	"	456	0	0	79	20	218	20	0	119	0	40
4	"	1132	0	0	0	0	79	854	0	199	0	60
5	"	1946	0	60	357	0	496	199	0	834	0	139
6	"	1071	20	0	99	0	357	337	20	238	0	60
7	"	457	0	0	20	0	119	0	159	159	0	40
8	"	1032	0	0	119	0	516	238	0	159	0	20
9	"	1211	0	0	179	0	99	179	536	218	0	0
10	"	1053	0	0	40	20	179	139	496	179	20	0
11	"	616	0	20	99	20	179	0	40	258	40	20
12	"	2263	20	60	615	0	1072	238	20	238	0	20
13	"	2938	79	20	437	0	1727	417	79	179	0	20
14	"	1569	0	0	516	0	457	437	40	119	40	60
15	"	2030	119	0	496	0	635	615	60	278	20	119
16	"	993	0	0	119	0	40	20	774	40	596	79
17	"	1687	60	0	298	79	615	40	79	516	0	60
18	"	358	0	0	60	0	139	40	20	99	0	0

TABLE XV (Cont'd)

SAMPLE LOCATION		ALGAE (number per milliliter)									INERT DIATOM SHELLS	
		TOTAL ALGAE	BLUE GREEN		GREEN		FLAGELLATES (pigmented)		DIATOMS			
Station No.	Depth		Coccoid	Filamentous	Coccoid	Filamentous	Green	Other	Centric	Pennate	Centric	Pennate
19	Surface	338	0	0	0	60	0	20	0	258	0	20
20	"	498	60	0	139	20	60	0	60	159	0	60
21	"	456	0	0	139	40	99	0	79	99	40	0
22	"	635	0	20	79	0	476	0	0	60	0	40
23	"	814	0	0	99	0	60	20	377	258	0	99
24	"	1072	0	0	79	0	337	0	457	199	20	0
25	"	2740	0	0	99	0	1231	60	1151	199	40	60
26	"	655	0	0	159	0	357	0	0	139	0	40
27	"	239	0	0	60	0	60	0	20	99	0	60
28	"	675	0	0	139	0	159	0	0	377	0	199
29	"	1450	20	397	397	0	417	179	0	40	0	0
30	"	1152	20	417	258	0	278	20	40	119	0	0
32	"	1052	0	20	139	20	139	0	476	258	0	20
33	"	1330	20	0	159	0	873	40	0	238	0	0
34	"	1906	0	20	298	0	516	238	0	834	0	99

lateral or major collector canal, they have physical similarities. The vertical sides are chiefly limestone overlain by thin layers of clay, sand and organic detritus. Deposits on the canal bottom vary in thickness but are basically the same composition as the sides. Spoil banks lined the sides of the canals.

Benthic invertebrate populations seemed closely correlated with the substrate type. In the organogenic bottom (organic detritus, leaf drift, etc.) sprawling mayfly nymphs (*Caenis diminuta*), the red midge larvae (*Chironomus* and *Cryptochironomus*), tubificid worms and ceratopogonid larvae dominated. Invertebrate densities in this soft substrate ranged from 90 to 1810 organisms per square meter. In the minerogenic bottom (sand, eroded limestone, etc.) fewer numbers of organisms were collected. Large burrowing dragonfly nymphs (*Aphylla williamsoni*), lumbriculid oligochaetes and caddisfly larvae (*Polycentropus*) were common inhabitants. Densities in this harder substrate ranged from 60 to 1418 organisms per square meter. The overlap in these ranges occurred because all degrees of intergradation existed between the hard and soft substrate.

Shorelines of newer canals were virtually barren except for sparse clumps of submerged naiads (*Najas*) and an occasional, small bed of emergents (i.e. *Typha*, *Sagittaria* or *Pontederia*). In contrast, the older canals in the GAC system (e.g. Stations 2, 3, and 4) often had dense growths of naiads and bladderworts (*Utricularia* spp.) that blanketed entire cross-sections. Immature insects and crustaceans (primarily Amphipoda) were profuse in this vegetative entanglement. Emergents along the shorelines of the older canals included: cattails (*Typha*), maidencane (*Panicum*), pickerelweed (*Pontederia*) and arrowhead (*Sagittaria*).

Organisms associated with these plants as well as other biota collected or observed in the GAC canals are listed in the Appendices.

Surficial water samples analyzed for phytoplankton showed this canal network had a population range from 179 to 2482 organisms per milliliter. Green flagellates and/or pennate diatoms were dominant in seven of the nine samples analyzed. The two exceptions were Stations 1 and 23. These are both major collector canals (Figure 2). At Station 1, approximately half the phytoplankton population was mixed coccoid green algae. Dominant genera included Chlorella, Golenkinia and Ankistrodesmus. At Station 23, nearly 80 percent of the phytoplankton population was mixed diatoms dominated by Melosira.

Examination of periphyton in the GAC canal system showed much repetition of the forms found in the plankton analyses. Dredging activities and changing water velocities caused loosening and suspension of periphyton, consequently they were collected and recorded with plankton. True plankters probably do not include such forms as the filamentous green algae (Spirogyra Sp.). The stations located within the GAC canal system are representative of the most developed area within the Big Cypress Swamp.

Generally, the changes in the ecology of this area broughout about by development is reflected somewhat by the comparatively low bacterial population. The extensive canal and road network has destroyed many of the natural habitats of animals once endemic to the area and has brought about their migration to less developed areas. The frequency with which wildlife, especially birds, were sighted in this area (Appendix C) together with the bacterial indicator data would tend to substantiate such a migration.

Geometric mean total coliform densities in this canal system ranged from 4600 to 23,900/100 ml and mean fecal coliform (FC) densities ranged from 8 to 50/100 ml. The latter densities were quite low.

Alligator Alley

The canal which parallels Alligator Alley intercepts drainage from Okaloacoochee Slough and the remainder of the northern half of Collier County. This drainage is then distributed to the numerous outlets under the Alley and from there it proceeds on its natural southerly course. The quality of water at any point in the canal varies with the quality of the nearby overland flow passing through it. A mixed layer of clay, sand and organic detritus of variable thickness has overlain the limestone bed of the canal.

Benthos collected along Alligator Alley reflected a minerogenic bottom, primarily sand. Invertebrate elements of the sandy bottom included snails (Physa spp.), large burrowing dragonfly nymphs (Aphylla williamsoni), and lumbriculid oligochaetes. In patches of silt deposition, 11 species of midges were collected. This midge population was dominated by the red-type larvae called bloodworms (Chironomus and Cryptochironomus). Invertebrate densities ranged from 830 to 1511 organisms per square meter.

Submerged vegetation was dominated by naiads (Najas spp) with bladderwort, Elodea, and water hyssop (Bacopa caroliniana) intermingled in smaller amounts. Mayfly nymphs (Caenis diminuta and Callibaetis floridanus), shrimp (Palaemonetes), Amphipoda (primarily Hyalella azteca) and damselfly nymphs (Ischnura spp.) were conspicuous faunal elements in the submerged vegetation.

Emergent vegetation common to the shorelines included pickerel weed (*Pontederia lanceolate*), fire flag (*Thalia geniculata*), arrowhead (*Sagittaria* spp.) and cattails (*Typha*). The root systems of these plants provided a habitat for Amphipods, planarians, mites, mayfly nymphs, diving beetles (*Suphisellus gibbulus*), and water bugs (*Belostoma*).

Floating plants common to the Alligator Alley canal included water lettuce (*Pistia stratroites*), water hyacinth (*Eichornia crassipes*), duckweeds (*Lemna* spp.), and water velvet (*Azolla*). As floaters, all of these plants were at the mercy of the canal currents and consequently their relative density at any site changed continuously.

Phytoplankton densities were generally two to three times higher than those of the GAC canals. Densities in the Alligator Alley canal ranged from 1032 to 2938 organisms per milliliter. Pigmented flagellates, mostly chlorophyll-bearing forms of the genera *Trachelomonas*, and *Pandorina* dominated the phytoplankton community. Next in abundance were the associations of coccoid green algae (*Ankistrodesmus*, *Scenedesmus* *Pediastrum* and *Chlorococcum*) that ranged in density from 119 to 615 cells per milliliter. The remaining community was composed of mixed green and blue-green algae and a variety of centric and pennate diatoms.

Color and turbidity were low (see chemical results) in the Alligator Alley canal, and light penetrated to the bottom at all the field stations. In places, periphyton coated all submerged objects. It was especially obvious on the stems of emergent aquatic plants. Arrowhead, pickerelweed and cattail had a green periphyton floc attached to their stems that often measured three to five cm thick.

Examination of artificial substrates (1 x 3-inch glass slides) submerged for three weeks at five locations in the canal showed the periphyton variation. Total counts ranged from 54 million to 364 million cells per square meter. Dry and ash periphyton weights varied from 0.74 to 3.80 and 0.19 to 1.17 g/m^2, respectively.

For additional biological and ecological data on the Alligator Alley canal, the reader should refer to Station 14 in the Appendix of this report.

Bacteriological data for the Alligator Alley stations are listed in Table IX. As is the case with most swamp drainage, the total coliform densities for the Alley stations ranged from 11,100 to 34,400/100 ml. Although the area is characterized by an abundant animal population, the presence of this population was not reflected in the fecal coliform densities encountered (geometric mean range of 23 to 54/100 ml).

The extremely high ratios of total to fecal coliforms would tend to suggest that a relatively unpolluted situation existed within the area. The topographical and hydrological features that exist probably influence these ratio relationships. Much of the effect of animal waste input could be minimized because of dilution from heavy rainfall in March, lack of scouring velocities needed keep wastes in suspension, and extended flow time which affects dieoff.

Tamiami Trail

South of Alligator Alley Canal was a second and older cross-state canal, the Tamiami Canal, which parallels the Tamiami Trail. Like the Alligator Alley Canal, the Tamiami Canal acts as an interceptor and distributor of sheet flow passing through the Big Cypress from the north. Numerous bridges and culverts allow water passage under U. S. 41. From Carnestown westward, the canal approximates the fresh and saltwater boundary.

Excavation of the canal resulted in sheer vertical walls of limestone. The flat canal bottom had a variable thickness of clay, sand and detritus overlying the limestone.

Benthos collected in the canal reflected an intergradation of organogenic and minerogenic substrate. Benthic fauna in the soft, fine detritus bottom included bloodworms (Chironomus spp.), ceratopogonids tubificid worms, and mayfly nymphs (Caenis diminuta). In the harder substrate of exposed sand, clay or eroded limestone, the benthic community was much more varied. In addition to the above-mentioned forms, there were numerous snails (Pomacea, Goniobasis, Helisoma), unionid clams, dragonfly and damselfly nymphs, mites, midge larvae and a variety of other aquatic insects, worms and crustaceans. Invertebrate densities ranged from 2,175 to 7,489 per square meter and appeared related to hard versus soft substrate respectively.

Terrestrial vegetation (trees) at the two canal stations (Stations 5 and 29) studied intensively was strikingly different. At Station 5, located in Dade County, the southern bank of the canal was lined with planted windrows of stately Australian Pine (Casuarina sp). At Station 29, located in Collier County, the southern bank had only an occasional cabbage palm (Sabal palmetto). Aquatic vegetation was somewhat varied as one proceeded along the canal but not as striking as these transplanted trees. Submerged plants included abundant growths of water hyssop (Bacapa caroliniana), bladderwort (Utricularia), naiad (Najas), and coontail (Ceratophyllum). Beds of muskgrass (Chara) and a filamentous green alga (Spirogyra) coated much of the submerged surface of exposed limestone.

Examination of artificial substrates (1 x 3-inch glass slides) submerged for three weeks at five locations in the canal showed the periphyton variation. Total counts ranged from 54 million to 364 million cells per square meter. Dry and ash periphyton weights varied from 0.74 to 3.80 and 0.19 to 1.17 g/m^2, respectively.

For additional biological and ecological data on the Alligator Alley canal, the reader should refer to Station 14 in the Appendix of this report.

Bacteriological data for the Alligator Alley stations are listed in Table IX. As is the case with most swamp drainage, the total coliform densities for the Alley stations ranged from 11,100 to 34,400/100 ml. Although the area is characterized by an abundant animal population, the presence of this population was not reflected in the fecal coliform densities encountered (geometric mean range of 23 to 54/100 ml).

The extremely high ratios of total to fecal coliforms would tend to suggest that a relatively unpolluted situation existed within the area. The topographical and hydrological features that exist probably influence these ratio relationships. Much of the effect of animal waste input could be minimized because of dilution from heavy rainfall in March, lack of scouring velocities needed keep wastes in suspension, and extended flow time which affects dieoff.

Tamiami Trail

South of Alligator Alley Canal was a second and older cross-state canal, the Tamiami Canal, which parallels the Tamiami Trail. Like the Alligator Alley Canal, the Tamiami Canal acts as an interceptor a distributor of sheet flow passing through the Big Cypress from the north. Numerous bridges and culverts allow water passage under U. S. 41. From Carnestown westward, the canal approximates the fresh and saltwater boundary.

Excavation of the canal resulted in sheer vertical walls of limestone. The flat canal bottom had a variable thickness of clay, sand and detritus overlying the limestone.

Benthos collected in the canal reflected an intergradation of organogenic and minerogenic substrate. Benthic fauna in the soft, fine detritus bottom included bloodworms (*Chironomus* spp.), ceratopogonids tubificid worms, and mayfly nymphs (*Caenis diminuta*). In the harder substrate of exposed sand, clay or eroded limestone, the benthic community was much more varied. In addition to the above-mentioned forms, there were numerous snails (*Pomacea*, *Goniobasis*, *Helisoma*), unionid clams, dragonfly and damselfly nymphs, mites, midge larvae and a variety of other aquatic insects, worms and crustaceans. Invertebrate densities ranged from 2,175 to 7,489 per square meter and appeared related to hard versus soft substrate respectively.

Terrestrial vegetation (trees) at the two canal stations (Stations 5 and 29) studied intensively was strikingly different. At Station 5, located in Dade County, the southern bank of the canal was lined with planted windrows of stately Australian Pine (*Casuarina* sp). At Station 29, located in Collier County, the southern bank had only an occasional cabbage palm (*Sabal palmetto*). Aquatic vegetation was somewhat varied as one proceeded along the canal but not as striking as these transplanted trees. Submerged plants included abundant growths of water hyssop (*Bacapa caroliniana*), bladderwort (*Utricularia*), naiad (*Najas*), and coontail (*Ceratophyllum*). Beds of muskgrass (*Chara*) and a filamentous green alga (*Spirogyra*) coated much of the submerged surface of exposed limestone.

Immature insects were the predominant invertebrate animals collected in this aquatic vegetation. Mayfly nymphs (*Caenis diminuta*) were especially abundant, and second only to a diverse population of midge larvae.

Emergent vegetation included cattail, pickerelweed, maidencane (*Panicum hemitomon*), arrowhead, smartweed (*Polygonum*), and sawgrass (*Mariscus jamaicensis*). The stems of many of these plants were attachment places for *Pomacea* snail eggs. These stems also provided attachment sites for periphyton, which was often observed in greenish flocs 3 to 5 cm thick. Fauna associated with these emergents included leeches, oligochaetes, endoprocta (*Urnatella gracilis*), molluscs, and numerous immature insects and crustaceans.

Floating plants common to the Tamiami Canal were water hyacinth (*Eichhornia crassipes*), duckweed (*Lemna*), spatterdock (*Nuphar advena*) and occasionally water lettuce (*Pistia stratioites*) and water velvet (*Azolla*). With the exception of spatterdock, these plants were all free-floating. Their density in portions of the canal were altered by spraying, by mechanical removal and/or by advection in the direction of canal currents. The root systems of these floaters provided niches for the aquatic stages of caddisflies, mayflies, dragonflies, damselflies, beetles, bugs, copepods, mites, molluscs, worms, flies and scuds. The fate of these invertebrates is often predetermined by destruction or transport of their plant habitat.

Phytoplankton populations ranged from 1152 to 2740 organisms per milliliter. Green pigmented flagellates, primarily *Pandorina* and *Trachelomonas*, dominated the community. Next in abundance was a mixed population of centric and pennate diatoms. Coccoid greens (*Pediastrum*, *Scenedesmus*, *Golenkina*, *Crucigenia*, *Staurastrum* and *Ankistrodesmus*) were third in density. At Stations 29 and 30, filamentous blue-greens (*Oscillatoria*, *Anabaena*, and *Lyngbya*) were collected in plankton samples. These forms were more closely associated with periphyton but were recorded as collected.

As previously mentioned, periphyton was abundant in the Tamiami Canal, and it coated most submerged objects. The most abundant filamentous greens were *Spirogyra* and *Zygonema*. Blue-greens were also common as periphyton. They included *Lyngbya*, *Nostoc*, *Anabaena* and *Oscillatoria*. In addition to these forms, artificial substrates (1 x 3-inch glass slides) collected an attached community of *Staurastrum*, *Scenedesmus*, *Cosmarium*, *Oocystis* and mixed diatoms. Densities varied from 32 million to 216 million cells/m^2. Dry and ashed periphyton weights from the artificial substrate showed average values ranging from 0.21 to 5.06 and 0.07 to 1.21 g/m^2 respectively.

The Cypress Swamp north of Tamiami Trail and near Station 28 was selected for special study. A portion, perhaps half, of the quadrat study area was not shaded by the dense cypress forest. In this open area, sunlight penetrated the clear, shallow water and provided suitable conditions for growth of rooted aquatics. A luxuriant growth of submerged *Najas* blanketed the sunlit bottom. Rooted aquatic growth stopped abruptly at the edge of the shaded zone. Within the densely shaded area, only a few scattered leaves of an emergent arrowhead were observed.

Invertebrates associated with submerged *Najas* were dominated by midge larvae (i.e. Tanypodinae, and Ceratopogonidae). Dragonfly and damselfly nymphs were also a conspicuous part of the invertebrate community in the submerged vegetation. Benthos in the soft substrate of both sunlit and shaded areas were dominated by an association of bloodworm larvae (Chironomus), leeches, and Oligochaetes.

Periphyton in the cypress swamp near Station 28 were restricted to the sun-exposed portion of the quadrat area. Unlike stations in the Tamiami Canal, e.g. Station 29, the periphyton in the swamp was dominated by small mixed diatoms. The abundant growths of long filamentous greens and blue-greens were absent. The total periphyton cell counts for Station 28 were 790 cells/mm^2 (mostly diatoms), while Station 29 had 216 cells/mm^2 (mostly filamentous algae). The biomass of these algal forms, however, were quite different. Their population differences are put into perspective by comparing the average dry and ashed weight values which accumulated over an equal time period. In the canal at Station 29, average dry and ash weights were 5.06 and 1.21 g/m^2 respectively. In the swamp at Station 28, average dry and ash weights were 3.23 and 1.06 g/m^2, respectively. Periphyton production was almost twice as high in the sun-exposed canal.

The effect of the swamp drainage on bacterial quality was reflected in the high total coliform densities found at the four Tamiami Canal stations. Mean total coliform densities ranged from 14,600 to 36,000/100 ml. Mean fecal coliform densities at these stations ranged from only 11 to 90/100 ml.

Like Alligator Alley, the Tamiami Trail area is characterized by an abundant animal population. The fecal coliform levels in the area, however, do not fully reflect the impact of this population.

Highway 29 and 840A Canals

The two north-south drainage canals which parallel Highways 29 and 840A are approximately five miles apart. Both drain a portion of the

Okaloacoochee Slough and intercept water from Alligator Alley and Tamiami Trail Canals.

For the most part, these canals have been excavated through the limestone that underlies all of the Big Cypress area. They have vertical channel banks of eroded limestone with a bottom channel substrate of sand, clay and detritus overlying the limestone. Bottom deposition in these sections seemed related closely to age of the canal. Some sections of the two canals have been constructed through sloughs, prairies and marshes. In these reaches, the vertical banks and bottom substrata were primarily organogenic.

Benthos of these canals reflected the varied substrate. The hard bottom (sand, clay and eroded limestone) provided niches for lumbriculid oligochaetes, burrowing dragonflies (*Aphylla williamsoni*), molluscs (*Physa*, *Helosoma*, *Ferrissia*) and numerous Tanytarsid midges. The soft bottom (organic detritus) provided a relatively uniform substratum and had a less diverse invertebrate community. Oligochaetes, Ceratopogonidae, red-midge larvae (*Chironomus* and *Cryptochironomus*), and cased caddis fly nymphs (*Agraylea*, *Leptocella* and *Oecetis*) populated this bottom type. Benthic populations ranged from 136 to 10,267 organisms per square meter in hard and soft bottoms, respectively.

Submerged vegetation was dominated by *Najas*, which often covered as much as 85 percent of the bottom. A submerged shoreline association included coontail (*Ceratophyllum*), water milfoil (*Myriophyllum*), and water hyssop (*Bacopa*). Damselfly nymphs (Ischnura spp.), immature caddisfly (*Cheumatopsyche*), mayfly nymphs (*Caenis diminuta*) and midge large (primarily *Rheotanytarsus*) populated the submerged vegetation.

Emergent vegetation common to the canal shorelines included cattails, pickerelweed, pondweed (Potamogeton), arrowhead and smartweed (Polygonum). Apple snail eggs (Pomacea) were common on the leaves and stems of many of these emergent plants. Leeches, oligochaetes, mites and limpets (Ferrissia) were also collected from submerged stems. The root systems were abundant with amphipods (Hyalella azteca), damselfly nymphs (Enallagma and Ischnura) and midge larvae (Chironomus, Clinotanypus and Tanytarsus).

Floating plants of these canals included water hyacinth, water lettuce, duckweed, floating heart (Nymphoides aquaticum), and water penny (Hydrocotyle umbellata). Their abundance varied from sparse to luxuriant, especially with regard to the water hyacinth density, throughout the two canal systems.

Phytoplankton were dominated by mixed centric and pennate diatoms. Pigmented flagellates (Trachelomonas and Dinobryon) were next in abundance. The remainder of the phytoplankton community was composed of coccoid and filamentous green algae, and at Station 17, coccoid blue-greens (Agmenellum) were recorded. Population values ranged from 239 to 1687 organisms per milliliter.

The most conspicuous periphyton in these canals was Nostoc. This blue-green was in the form of small colonial balls, and these pea-sized balls were found attached to most submerged objects. Abundantly associated with this attached alga were two other filamentous forms, Anabaena (blue-green) and Cladophora (green).

Artificial substrates collected a variety of periphyton in the Highway 29 and 840A canal systems. Populations on the substrate samplers varied from nine million to over one billion cells per square meter.

Bacteriological data for the Highway 29 canal Stations (9, 10, 24) and Highway 840A canal Stations (17, 26, 27) are shown in Table IX. With two exceptions, Stations 10 and 24 on the Highway 29 canal, the two canal systems are similar bacterially. Station 10 receives drainage from Immokalee and the Okaloacoochee Slough. The Station 10 area is characterized by a heavy bird population, the effect of which is reflected in the bacterial indicator level at this station. The mean fecal coliform density at Station 10 was 100/100 ml. Station 24, further downstream, had a geometric mean fecal coliform density of 95/100 ml.

A consideration of the two canals together revealed a mean total coliform density range of 11,700 to 24,700/100 ml and a mean FC range from 40 to 100/100 ml.

L-28 Interceptor Canal

The L-28 Interceptor Canal located near the Dade-Collier County line is part of the Corps of Engineers, southern Florida, Water Conservation Pool system. This canal (Station 16) resembled the new canals of the GAC system. Spoil was banked along the right-of-way, and the immediate shorelines were virtually barren. The canal was uniform in width and depth. It had sheer banks of exposed limestone with a bedrock channel bottom covered by differing thicknesses of clay, organic detritus and sand.

Benthos inhabitating the soft, mid-channel substrate were dominated by a Polypedilum-Chironomus midge larvae community. Nearer the shoreline in the organic detritus, Oligochaete worms and Caenis (mayfly) nymphs were numerous (144 and 129/m^2 respectively). Total invertebrate population in the canal bottom ranged from 257 to 1677 organisms per square meter.

Aquatic vegetation was sparse. Near each shore and extending into the channel 4 to 5 meters were beds of Najas. Other rooted aquatics were restricted to small, scattered beds of arrowhead.

The phytoplankton population totaled 993 organisms per milliliter. A variety of centric diatoms were found in greatest abundance.

Periphyton growth was dominated by pennate diatoms. Other common algal forms included blue-greens of the genera Anabaena, Oscillatoria, and Lyngbya, and various coccoid and filamentous greens. The total population was recorded as 38 million cells per square meter.

Upper Okaloacoochee Slough

This slough is located in the north central region of Collier County. Aquatic biology of the slough was studied at Station 11, although bacterial and chemical analyses were made at two sites, Stations 11 and 31.

Station 11 was located on a small drainage canal that had been excavated through sandy substrate. The canal served as a drainage channel to help reclaim the surrounding prairie for cattle pasturelands. Overlying the sandy canal bottom was a thin layer of peat.

An abundance of fingernail clams (91 Sphaeriidae/m^2) reflected the hard, sandy type bottom. In the thin overlayer of peat, oligochaetes, midge larvae (mostly Chironomus (K) dux) and Oecetis caddisfly larvae were common.

Aquatic vegetation was dominated by floating water lettuce. It covered approximately 50 percent of the water surface at the sampling site. The western shoreline of the canal was not well drained. A thin sheet of water covered much of this bank during March, and a dense stand of arrowhead and pickerel weed was present. Other shoreline vegetation included smartweed and panic grasses.

The total phytoplankton population was recorded as 616 cells per milliliter. Approximately half (258 cells) of these organisms were pennate diatoms. Other significant forms included green pigmented flagellates and green coccoid algae (Chlorella). A few strands of blue-green algae (Anabaena) were also collected with the phytoplankton.

Periphyton growth on artificial substrates approached the most sparse density found in the Big Cypress area. A total periphyton count of 15 million cells per square meter was recorded. Blue-greens accounted for one-third of the population. The remaining composition was a mixture of diatoms and green filamentous algae (Spirogyra). Dry and ash periphyton weight of this community was 0.49 and 0.049/m^2 respectively.

Bacterial data for the Upper Okaloacoochee Slough Stations (11,31) are shown in Table IX. Mean total coliform densities at these stations were 18,600 and 15,700/100 ml respectively. Mean fecal coliform densities were 32 and 7/100 ml respectively. Both of these stations were located in waters which drained partially from livestock grazing land. The effects of animal waste on water quality at these stations was minimized during March because of the dilution effect of an exceptionally large volume of storm water entering the Swamp at these points.

Fakahatchee Strand

Janes Scenic Drive transects the Fakahatchee Strand some four to eight miles north of the Tamiami Trail. Two of the biological study sites (Stations 20 and 22) in the strand were located in the water area immediately adjacent to the drive. Near Station 21, a special study was made of an undisturbed portion of the strand.

90a

Upper Okaloacoochee Slough (Station 11)

A 10-meter quadrat in the strand was used for the special study. The central portion of the quadrat was fully exposed to direct sunlight. As was found in other unshaded areas of the swamp (Station 28), the bottom was blanketed with a luxurious growth of Najas. The growth covered the bottom of about 65 percent of the quadrat. Along the margins of the Najas bed, in more shallow water, there were pickerelweed and arrowhead plants. These emergents rooted in a sandy substrate where detritus had built up to a depth of several inches.

Generally, the strand was similar in its biological composition to many of the canals studied, especially aged canals. This was not considered too unusual since a strand (sometimes slough is used interchangeably) is a broad, shallow, natural canal.

Biological study at Stations 20 and 22 was limited to examination of plankton, periphyton and bacteria. Total numbers of phytoplankton at Stations 20 and 22 were similar. Counts were 498 and 635 cells/ml, respectively. Examination of the type of organisms in each of these populations, however, showed little similarity in composition. At Station 20, a mixed diatom population (mostly pennates) dominated. Other major components included coccoid greens (Chlorella and Ankistrodesmus) and blue-greens (Merismopedia). At Station 22, green pigmented flagellates (Euglenaceae) dominated. Other major elements of the plankton included coccoid greens (Chlorella and Scenedesmus), mixed pennate diatoms and filamentous blue-greens (Anabaena).

Periphyton collected from artificial substrates at Stations 20 and 22 were dissimilar also. At Station 20, the cell count was recorded as 247 million cells per square meter. At Station 22 the cell count was much lower, i.e. 28 million cells per square meter. Comparison of the population elements and periphyton weights at Stations 20 and 22 are summarized in Tables XIII and XIV.

Stations located in the Fakahatchee Strand (20, 21 and 22) received overland sheet runoff from a rather unique cypress strand area. This area had a diverse wildlife population. The presence of this diverse animal population is especially reflected in the FC bacterial densities encountered at Stations 20 and 22. These two Stations had mean FC densities of 140 and 120/100 ml respectively. Station 21, located in the same area, had a considerably lower mean FC density (50/100 ml). The lower fecal coliform density at this site may be due, in part, to heavy use of the site for fishing which noticeably reduced the bird population.

Special Biological Study Areas

Special biological studies were conducted at three other sites in the Big Cypress area. Detailed characteristics of these sites are presented in the Appendices. Each study site can be referred to by its station location number or its habitat type as follows:

Station Number	Habitat Type
32	Cypress Pond
33	Wet Prairie
34	Sawgrass Marsh

REFERENCES CITED

(1) U. S. Department of Interior, Environmental Impact of the Big Cypress Swamp Jetport, September, 1969.

(2) U. S. Department of Agriculture, Soil Survey, Collier County, Florida. Series 1942, No. 8, March 1954.

(3) U. S. Geological Survey, Ground-water Resources of Collier County, Florida, Report of Investigations No. 31, 1962.

(4) Personal Communication, Donald W. Lander, Collier County Agent, March 1970.

(5) Brogdon, J. E., Marvel, M. E., and Mullin, R. S., Commercial Vegetable Insect and Disease Control Guide, Florida Agricultural Extension Service, Circular 193F, June 1967.

(6) Beck, William M., "The Streams of Florida" Bulletin of the Florida State Museum, Volume 10, No. 3, 1965.

(7) U. S. Department of the Interior, Geological Survey, Preliminary Determinations of Hydro-biological Conditions in the Vicinity of the Proposed Jetport and Other Airports in South Florida, February 1970.

(8) Mackenthun, K. M., "The Phosphorus Problem", Journal AWWA, 60, pp. 1047-1054, September 1968.

(9) U. S. Department of Health, Education and Welfare, Public Health Service Drinking Water Standards (1962). Public Health Service Publication No. 956.

(10) Official Communication from John F. Kopp, U. S. Department of the Interior, FWQA, Cincinnati, Ohio, April 30, 1970.

(11) Kopp, John F. and Kroner, Robert C. Trace Metals in Waters of the United States. U. S. Department of the Interior, FWPCA, Cincinnati, Ohio, 1967.

(12) Van Meter, N. N. Preliminary report on the periphyton study. University of Miami, To Superintendent of Everglades National Park, 1961.

(13) Tabb, Durbin C., A Summary of Existing Information on Freshwater, Brackish-Water and Marine Ecology of the Florida Everglades Region in Relation to Fresh-water Needs of Everglades National Park, Institute of Marine Science, University of Miami, 1963.

(14) U. S. Department of the Interior, Bureau of Sports Fisheries and Wildlife, Rare and Endangered Fish and Wildlife of the United States. Resource Publication 34, December 1968.

(15) Weber, C. I., Methods of Collection and Analysis of Plankton and Periphyton Samples in the Water Pollution Surveillance System, Federal Water Pollution Control Administration, Div. of Pollution Surveillance, July 1966.

(16) American Public Health Association, Standard Methods for the Examination of Water and Wastewater, Twelfth Edition, 1965.

(17) Geldreich, E. E., Clark, H. F., Huff, C. B. and Best, L. C., "Fecal Coliform Organism Medium for Membrane Filter Techniques", Journal AWWA, 57, No. 2, (February 1965).

APPENDIX A

PART 1

SAMPLING STATION SITE DESCRIPTION

Station Number	Description
1	GAC Corporation (Golden Gate) canal crossing Pulling Road in Naples, Florida. R25E, T49S, corner of sections 25, 26,35,36. Collier County.
2	Canal crossing GAC road to Naples Fruit & Vegetable Co. In Golden Gate Estates. R26E, T49S, corner of sections 1,2,11,12. Collier County.
3	GAC canal crossing same road as # 2. R27E, T49S, Sections 1,12. Collier County.
4	GAC canal crossing same road as # 2. On line between R27E and R28E, T49S, corner of sections 1,6,12,7. Collier County.
5	Southern end of canal draining along west side of Conservation Area No. 3A. At Tamiami Trail. Dade County.
6	GAC canal crossing Alligator Alley, Florida Highway 84, at mile 7.7. At intersection of R27E and R28E and T49S and T50S. Collier County.
7	GAC canal crossing Alligator Alley, Florida Highway 84, at mile 9.7. Collier County.
8	Bridge on Alligator Alley, Florida Highway 84, at mile 16.5.
9	Barron River canal at junction of Alligator Alley and State Highway 29 at Miles City.
10	Barron River canal on Florida Highway 29, 5 miles north of Alligator Alley.
11	Bridge on Florida Highway 840 over Okaloacoochee Slough, 3 miles east of Florida Highway 29. R30E, T48S, section 14. Collier County.
12	Bridge on Alligator Alley, Florida Highway 84, at mile 27.8. R31E, T49S, section 32. Collier County.
13	Bridge on Alligator Alley, Florida Highway 84, at mile 32.6. R32E, T49S, section 31. Collier County.
14	Bridge on Alligator Alley, Florida Highway 84, at mile 37.3. USGS gage on north side of road. R32E, T49S, section 35. Collier County.

Station Number	Description
15	Bridge on Alligator Alley at mile 44.6. R34E, T49S, section 31. Collier County.
16	Bridge over L-28 Interceptor Canal on Alligator Alley at mile 49.8. R34E, T49S, section 35. Collier County.
17	Bridge over Turner River canal alongside Florida Highway 840A, 4.4 miles south of Alligator Alley. R31E, T50S, section 19. Collier County.
18	GAC canal in Remuda Ranch Estates, 150 yards north of end of canal. R28E, T51S, section 6. Collier County.
19	GAC canal in Remuda Ranch Estates at canal end. R28E, T51S, section 4. Collier County.
20	First wooden bridge on Janes Scenic Drive about 3 miles from fire tower.
21	Janes Scenic Drive, 5.8 miles northwest of USGS gage (Station 22).
22	Janes Scenic Drive, R29E, T51S, section 34, Fakahatchee Strand, at USGS gage site. Collier County.
23	Main canal from GAC Corporation's Remuda Ranch Estates at Tamiami Trail (U. S. Highway 41). R28E, T52S, section 10. Approximately 1/2 mile north of salinity control dam. At USGS gage.
24	Florida Highway 29, Barron River Canal immediately north of Copeland, Florida. USGS gage site. Collier County.
25	Tamiami Trail at Bridge No. 77, east of Carnestown, Florida. USGS gage site. Collier County.
26	Turner River canal alongisde Florida Highway 840A, 4.2 miles north of Tamiami Trail. R30E, T52S, section 12. Collier County.
27	Turner River canal at junction of Tamiami Trail and Florida Highway 840A. Collier County.
28	Tamiami Trail at Bridge No. 86, Turner Slough. Collier County.
29	Tamiami Trail at Bridge No. 100. Collier County.
30	Tamiami Trail at Bridge No. 105. Collier County.

Station Number	Description
31	Bridge Crossing Okaloacoochee Slough on Florida Highway 846. R30E, T47S, section 2. Collier County.
32	Cypress pond, 1.7 miles west of Florida Highway 29 and 0.8 miles south of Alligator Alley. Collier County.
33	Wet prairie, 1.5 miles west of Florida Highway 29 and 0.8 miles south of Alligator Alley. Collier County.
34	Sawgrass marsh, 0.1 miles north of Tamiami Trail and 200 feet west of Conservation Area No. 3A (near Station 5). Dade County.

PART 2

DETAILED DESCRIPTION OF BIOLOGICAL STATIONS

STATION 1

The sampling site was in the principal GAC Corp. canal draining from Golden Gate Estates westward to the Gulf of Mexico at Naples, Florida. The site was located immediately downstream from the Pulling Road bridge near the Naples Municipal Airport.

The symetrical channel had a maximum, mid-channel depth of 1.6 meters and a uniform width of 30 meters. The bottom consisted of calcareous bedrock covered by a thin layer of organic detritus, silt, clay and sand. Areas of exposed sand were present near both shorelines, with the larger deposit along the northern bank. (Figure A-1)

On the upstream side of the Pulling Road bridge was a large mesh screen stretched across the surface of the water. It prevented passage of floating plants and debris. Periodically, the material was removed by dragline and hauled away.

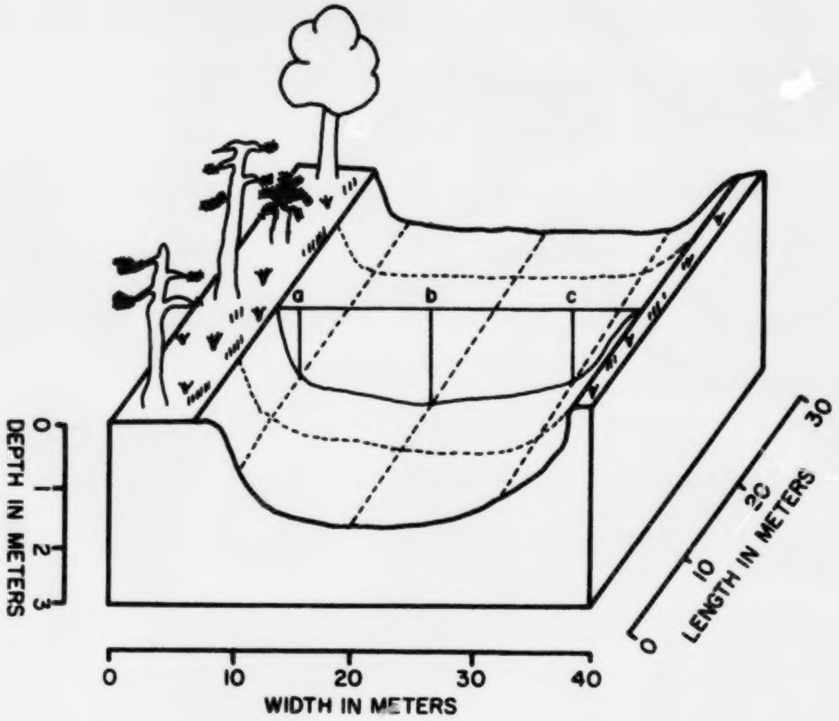
Immediately adjacent to the canal, the land was covered with a dense stand of mixed grasses. This succeeded into a forest of slash pine with an occasional red maple and sabal palm. The understory was dominated by saw palmetto, willow and bay.

Approximately two miles upstream (east) was a subdivision (Golden Gate) of 500 dwellings. Effluent from the activated sludge sewage treatment plant serving the subdivision discharged into this canal.

STATION 4

The station was in a tributary canal of the GAC Corporation canal system.

FIGURE A-1
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION I


a
b
c
DEPTH IN METERS
0
1
2
3
LENGTH IN METERS
0
10
20
30
0
10
20
30
40
WIDTH IN METERS

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	M	M	A	
b	M		M	A
c	L		L	A

KEY

A Abundant Component - Greater Than 40 %
L Less Abundant Component - 10 to 40 %
M Minor Component - Less Than 10 %

During the biological field survey, the water in the canal was low. Portions of the channel bottom were exposed and made the canal width irregular. Maximum water depth was 1.0 meters and maximum width was 2.75 meters. Detritus, clay, and some sand covered the canal's bedrock base. The thickest deposit of detritus was along the eastern shore (Figure A-2).

The shorelines were cleared of trees, except for an occasional bay or willow, for a distance of 75 meters on either side of the channel. Mixed grass-sedge vegetation covered these shore areas. The forest beyond was dominated by cypress, interspersed with pine and palm. The understory was a mixture of willow, bay, saw palmetto and grasses.

Approximately 4 miles north of the site was the proposed development of North Golden Gate Estates. The Audubon Society Sanctuary known as Corkscrew Swamp was three miles further north.

STATION 5

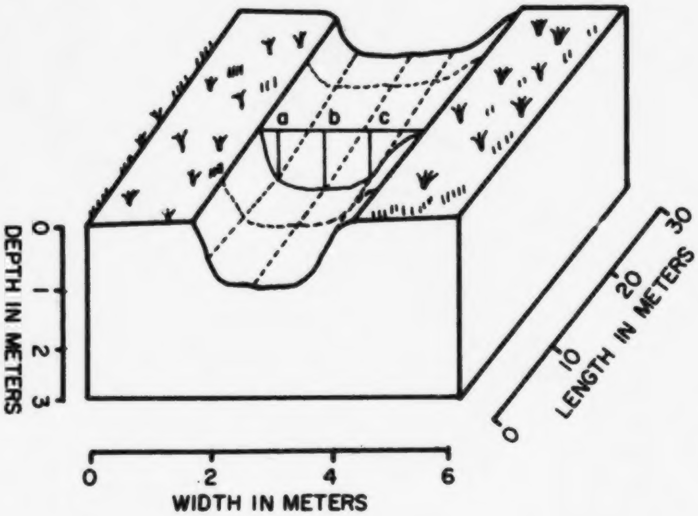
The site was in the Tamiami Trail canal near the Dade-Collier County line. The portion of the canal studied was in Dade County at the junction of the canal draining along the west side of Conservation Area 3A.

The canal was nearly symetrical. It had a width of 11 meters and a mid-channel depth of 3 meters. The bedrock bottom was covered by a thick deposit of clay and organic detritus. The vertical banks of exposed limestone had little or no soft substrate cover (Figure A-3).

U. S. Highway 41, the Tamiami Trail, paralleled the south side of the canal. Between the road and canal was a windrow of Australian pines. The northern shorelines was 50 meters from Conservation Area 3A. The land between Area 3A and the canal had a sparse upperstory of willow and dwarf cypress with

A-5a

FIGURE A-2
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 4



a
b
c
DEPTH IN METERS
0
1
2
3
0
2
4
6
WIDTH IN METERS
0
10
20
30
LENGTH IN METERS

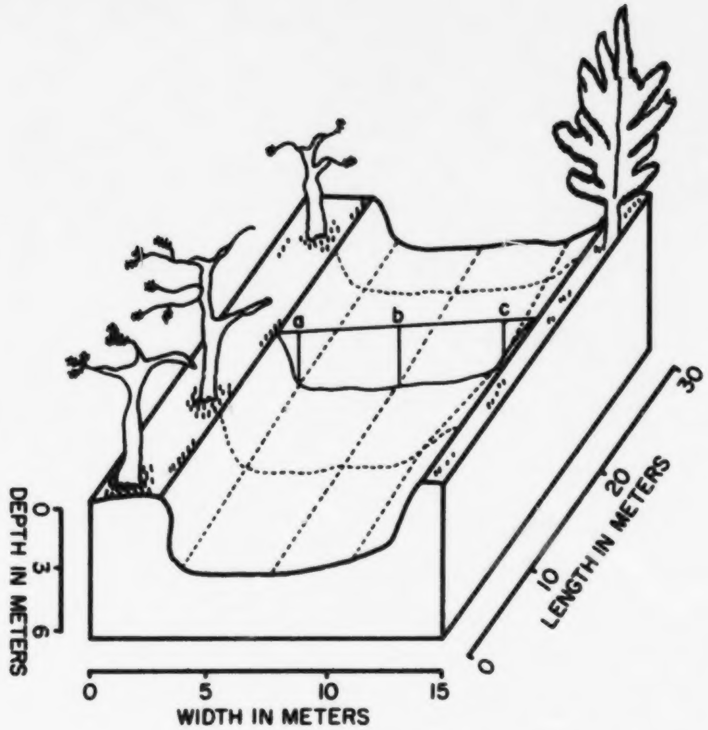
BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a		A	M	
b		A	M	
c	A	M	M	L

KEY

A Abundant Component - Greater Than 40 %
L Less Abundant Component - 10 to 40 %
M Minor Component - Less Than 10 %

A-5 b

FIGURE A-3
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 5



a
b
c
DEPTH IN METERS
0
3
6
WIDTH IN METERS
0
5
10
15
LENGTH IN METERS
0
10
20
30

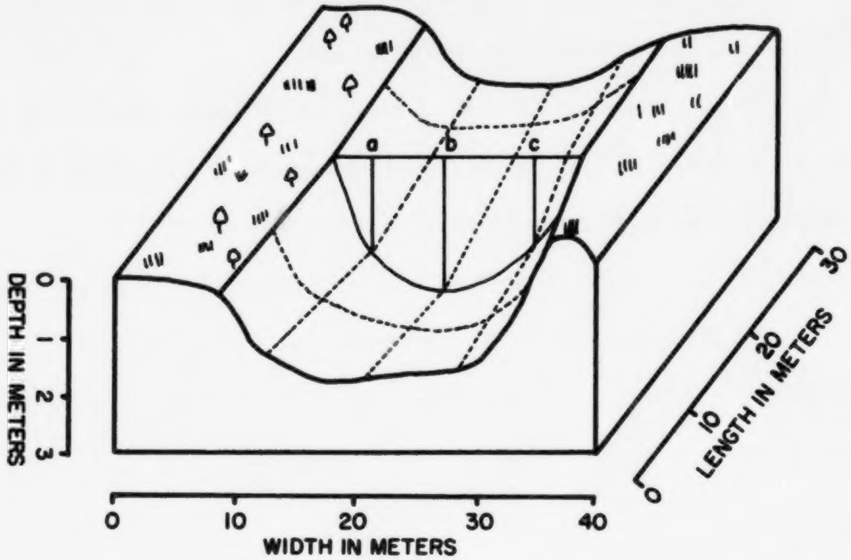
BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	M	A		
b	M	A		
c	M	A		M

KEY

A Abundant Component - Greater Than 40 %
L Less Abundant Component - 10 to 40 %
M Minor Component - Less Than 10 %

A-5C

FIGURE A-4
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 11



a
b
c
DEPTH IN METERS
0
1
2
3
0
10
20
30
40
WIDTH IN METERS
0
10
20
30
LENGTH IN METERS

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	M		A	
b	L		A	
c	M		A	

KEY

A Abundant Component - Greater Than 40 %
L Less Abundant Component - 10 to 40 %
M Minor Component - Less Than 10 %

an understory carpet of mixed grasses and sedges. A boat launching area was located 15 meters west of the transect station.

STATION 11

This sampling site was in a drainage ditch located in the Okaloacoochee Slough. The ditch drained the surrounding prairie, and the reclaimed land was used exclusively for cattle pastureland.

The channel was cut through a sandy substrate. Overlying the sand bottom was a thin layer of peat. Maximum depth of the channel was 2.2 meters and its width was a uniform 20 meters (Figure A-4).

Water hyacinth and water lettuce were in dense floating beds at this site. In places they completely carpeted the water surface. The western shoreline was not as well drained as the eastern; and it supported a stand of aquatic emergents dominated by pickerelweed.

STATION 14

The sampling site was in a flow-through canal passing under Alligator Alley. The upstream edge of the transect began at the northern end, extending southward for 30 meters. A Geological Survey stream gage and pier was on the western bank.

The canal had a uniform width of 40 meters and a mid-channel depth of 3 meters. The sandy bottom had thin layers of silt, clay and detritus (Figure A-5).

The station was adjacent to a principal route for traffic moving east and west across lower Florida (Highway 84). Land use was restricted to the maintenance of road shoulders and vegetation control.

Terrestrial plants on the immediate canal shorelines were mixed grasses and sedges with occasional willows. To the north and along the Alley Canal, cypress, ash, maple, palm and bay formed a dense forest.

STATION 16

The sampling station was in the L-28 Interceptor Canal. The downstream edge of the transect began 40 meters north of Florida Highway 84 (Alligator Alley).

The symetrical channel was excavated through limestone. The uniform width was 60 meters. Overlying the limestone was a thick deposit of detritus and clay. Near each shoreline an exposed lens of sand was observed (Figure A-6).

The interceptor canal was a major drainage channel. It drained from the Big Cypress Federal Indian Reservation located in Hendry County about 6 miles to the north. The canal banks were denuded. A graded road was maintained on both sides of the canal right-of-way.

To the northeast of the sampling site, a prairie was being used to pasture cattle. Beyond the prairie, the vegetation succeeded into a mixed cypress and hardwood forest.

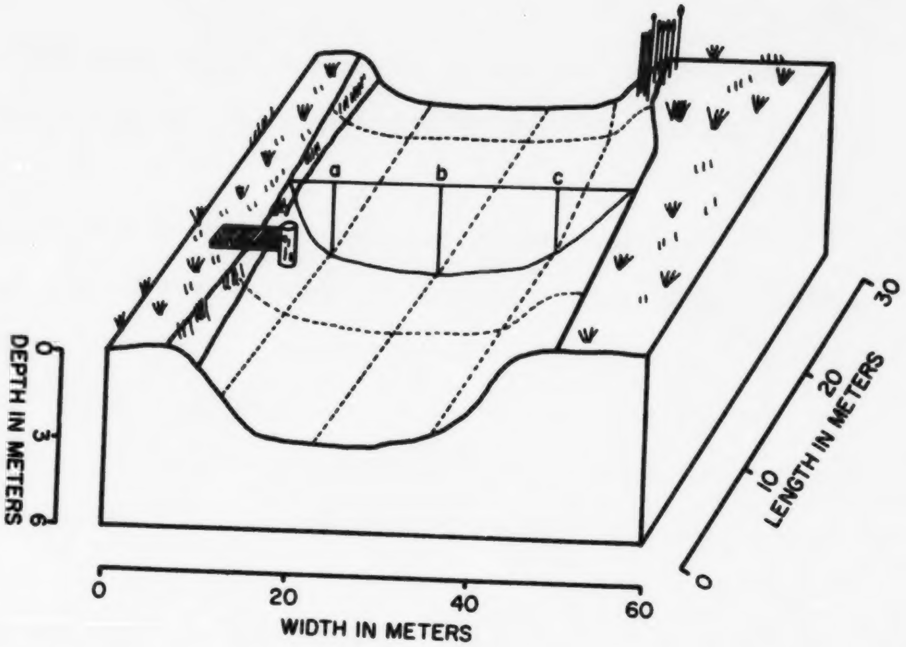
STATION 17

The station was in a canal that paralleled an improved gravel road, Florida Highway 840A. The sampling site was located in that portion of the canal (Turner River Canal) that channeled through the southeastern section of Okaloacoochee Slough, about 4 miles south of Alligator Alley.

The canal was 15 meters wide and had a mid-channel depth of 2.8 meters. Clay and detritus covered the bedrock channel bottom (Figure A-7).

A-7a

FIGURE A-5
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 14



a
b
c
DEPTH IN METERS
0
3
6
LENGTH IN METERS
0
10
20
30
WIDTH IN METERS
0
20
40
60

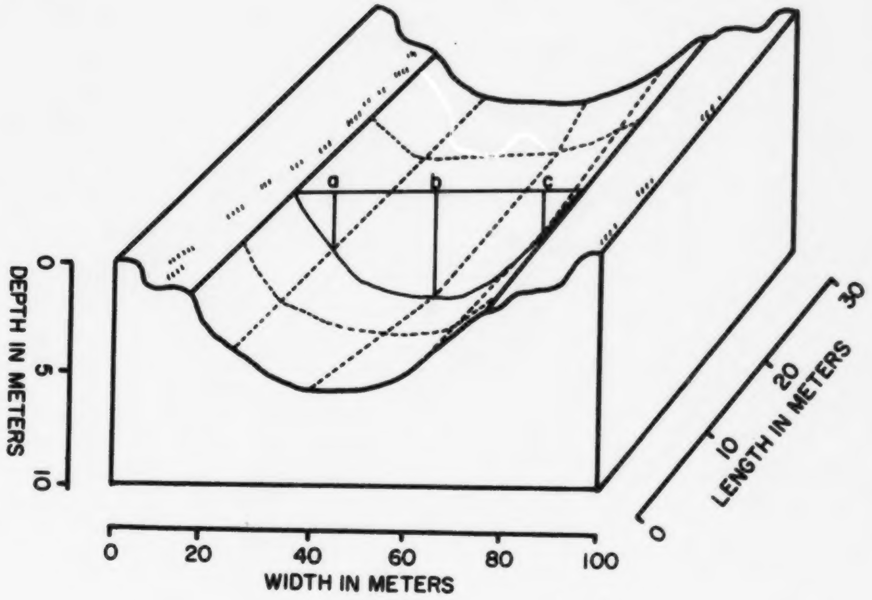
BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	M	M	A	
b		M	A	
c	M	M	A	

KEY

A Abundant Component - Greater Than 40%
L Less Abundant Component - 10 to 40%
M Minor Component - Less Than 10%

A-78

FIGURE A-6
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 16

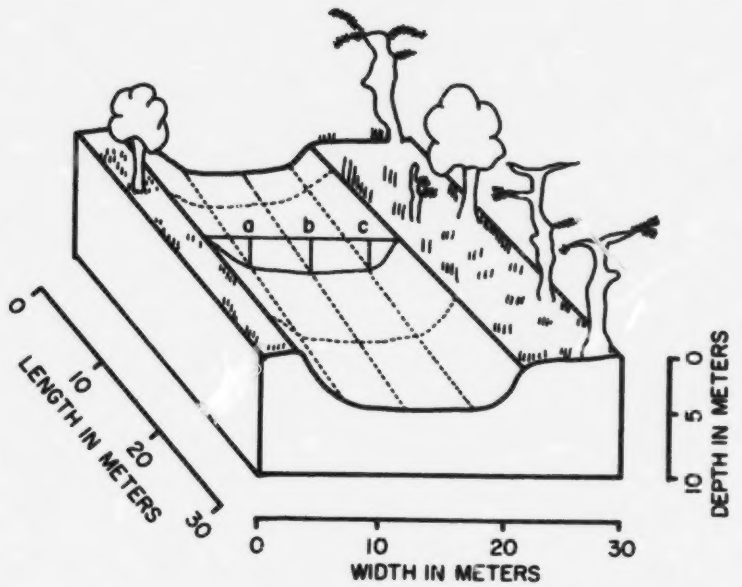

a
b
c
DEPTH IN METERS
0
5
10
0
20
40
60
80
100
WIDTH IN METERS
LENGTH IN METERS
0
10
20
30

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a		A	L	M
b		A		
c	M	A	L	M

KEY

A Abundant Component - Greater Than 40 %
L Less Abundant Component - 10 to 40 %
M Minor Component - Less Than 10 %

FIGURE A-7
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 17



a
b
c
0
10
20
30
LENGTH IN METERS
0
10
20
30
WIDTH IN METERS
0
5
10
DEPTH IN METERS

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	L	A		L
b	L	A		L
c	L	A		L

KEY

A	Abundant Component - Greater Than 40 %
L	Less Abundant Component - 10 to 40 %
M	Minor Component - Less Than 10 %

This canal was a major north-south drainage channel. It drained a portion of Okaloacoochee Slough and intersected with Alligator Alley and Tamiami Canal Systems as it continued southward to join the Turner River.

Major nearby land uses seemed restricted to hunting and fishing. The Dade/Collier Jetport was 25 miles southeast of the station, and during the biological sampling period, several jet training flights passed over the area at low altitudes.

Florida Highway 840A bordered the western shoreline. On the east a forest of cypress, wax myrtle and willow dominated the vegetative complex.

STATION 18

The station was in a GAC Corporation canal near the Remuda Ranch development.

The channel had been excavated recently. Both shorelines were denuded dredging spoil. The channel width was 45 meters with a mid-channel depth of 4.4 meters. The bottom consisted of clay and detritus overlying sand and limestone. Along the eastern shore was an extensive area of exposed sand (Figure A-8).

A forest type of mixed hard and softwoods was located 75 meters from each shoreline. Dominant tree types were cypress, willow and pine.

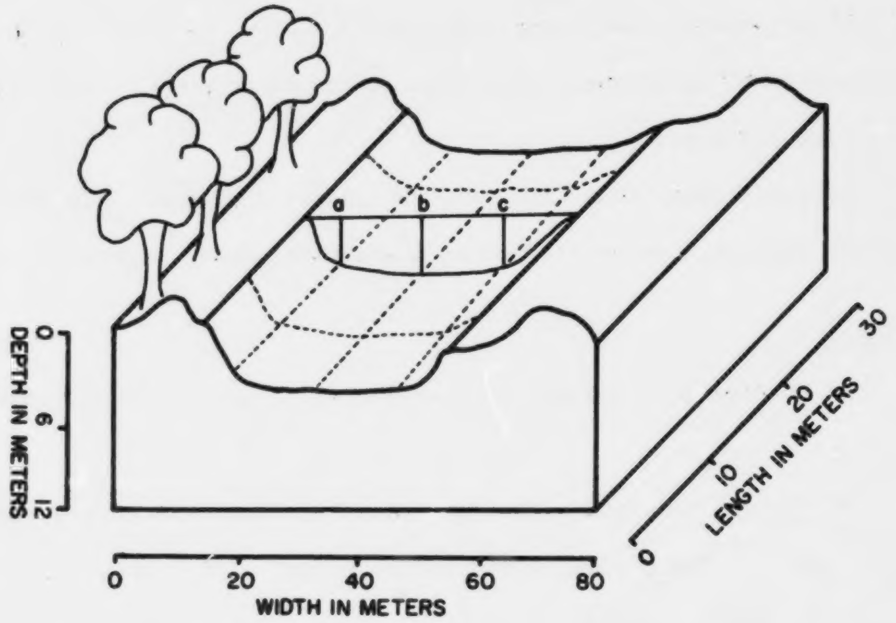
Nearby land uses appeared entirely centered around land reclamation for housing development.

STATION 21

This station was a 10 meter quadrat in a cypress slough. The site was located adjacent to the Janes Scenic Drive near the western border of Fakahatchee Strand.

A-8a

FIGURE A-8
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 18


a
b
c
0
6
12
DEPTH IN METERS
0
20
40
60
80
WIDTH IN METERS
0
10
20
30
LENGTH IN METERS

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	M	A		
b	M	A		
c	M	M	A	M

KEY

- A Abundant Component - Greater Than 40 %
- L Less Abundant Component - 10 to 40 %
- M Minor Component - Less Than 10 %

The substrate was limestone bedrock and sand covered with a soft layer of clay and organic detritus. Maximum water depth in the study quadrat was one meter (Figure A-9).

The cypress strand along most of Janes Scenic Drive was posted by the GAC Corporation. Presently the area is used exclusively for sightseeing, hunting, and fishing. The GAC Corporation has planned a drainage canal to be located 0.3 mile west of Station 21. Plans for development by GAC include connection of Janes Scenic Drive to the network of roads built or being built to the west.

The Fakahatchee Strand area is the major natural drainage of the southwestern Big Cypress Swamp, and it supports a unique stand of mixed cypress and native royal palm.

STATION 23

The sampling site was in a main GAC Corporation collector canal near the Remuda Ranch development. The canal system of which the collector is a part drains an area from Florida Highway 846, near Corkscrew Marsh, southward to Fahka Union Bay in the Ten Thousands Islands.

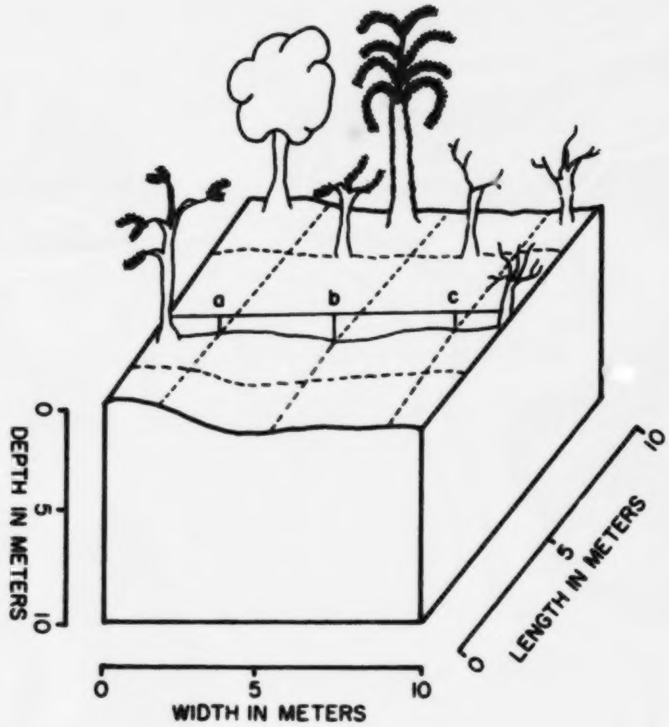
The canal had a maximum mid-channel depth of 4.6 meters and a uniform width of 60 meters. The bottom consisted of detritus, clay and sand overlying limestone (Figure A-10).

Facilities at Remuda Ranch included: (a) a motel complex, (b) riding stables, (c) a camper trailer park, and (d) a rifle range. Also on the eastern shore was a Geological Survey stream gage and pier and an 18-inch storm drain that emptied into the canal.

The western shore was relatively undisturbed. Maidencane and willow have grown on land nearest the canal. Westward the vegetation succeeded into a

A-9a

FIGURE A-9
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 21


a
b
c
DEPTH IN METERS
0
5
10
WIDTH IN METERS
0
5
10
LENGTH IN METERS
0
5
10

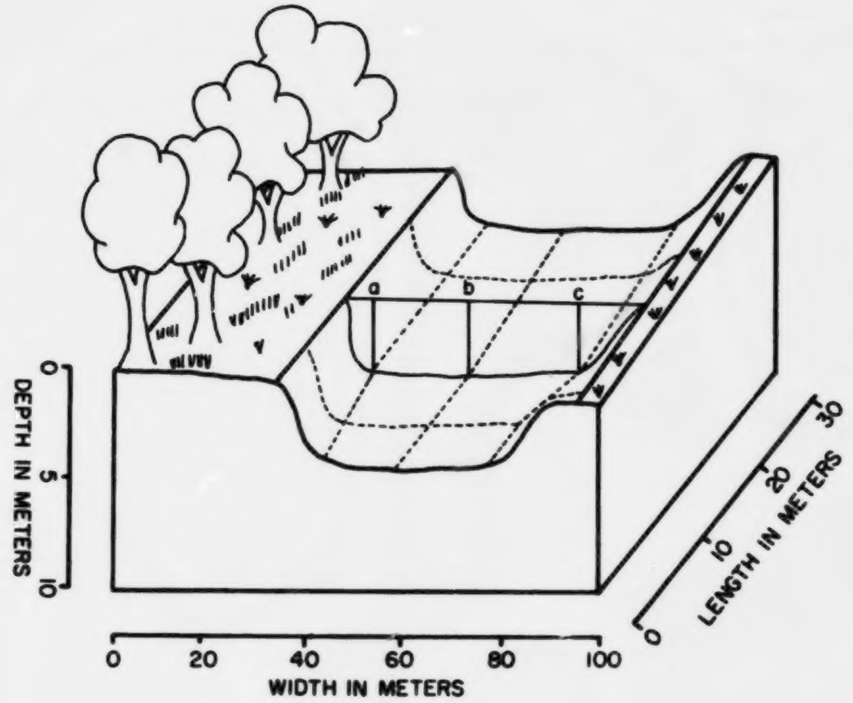
BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	M	M	A	L
b	L	M	A	L
c	L	M	A	L

KEY

A Abundant Component - Greater Than 40%
L Less Abundant Component - 10 to 40%
M Minor Component - Less Than 10%

A-9b

FIGURE A-10
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 23



a
b
c
DEPTH IN METERS
0
5
10
0
20
40
60
80
100
WIDTH IN METERS
0
10
20
30
LENGTH IN METERS

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	M	A	M	M
b	M	A		M
c	M	A	M	M

KEY

A Abundant Component - Greater Than 40%
L Less Abundant Component - 10 to 40%
M Minor Component - Less Than 10%

mixed hardwood forest with scattered palm and cypress. A dense stand of cabbage palm was southwest of the sampling site.

A dredging operation upstream about 1.5 miles caused high turbidity at the sampling site during the biological work. Another activity that could affect biota at the station was the mosquito control program being conducted at Remuda Ranch. Aerial spraying was done on the day biological samples were being collected. The fog was broadcast over the canal and surrounding area.

STATION 27

The station was in a major north-south drainage canal (Turner River Canal) parallel to Florida Highway 840A. The site was located 150 meters north of a wayside park at the U. S. Highway 41 and 840A junction.

The canal was 20 meters wide and had a mid-channel depth of 1.5 meters. The bottom consisted of bedrock overlain by sand, detritus, and clay (Figure A-11).

The canal's source was in the Okaloacoochee Slough north of Alligator Alley (Highway 84). It joined the Alligator Alley canal and carried water from these two areas southward past the sampling site.

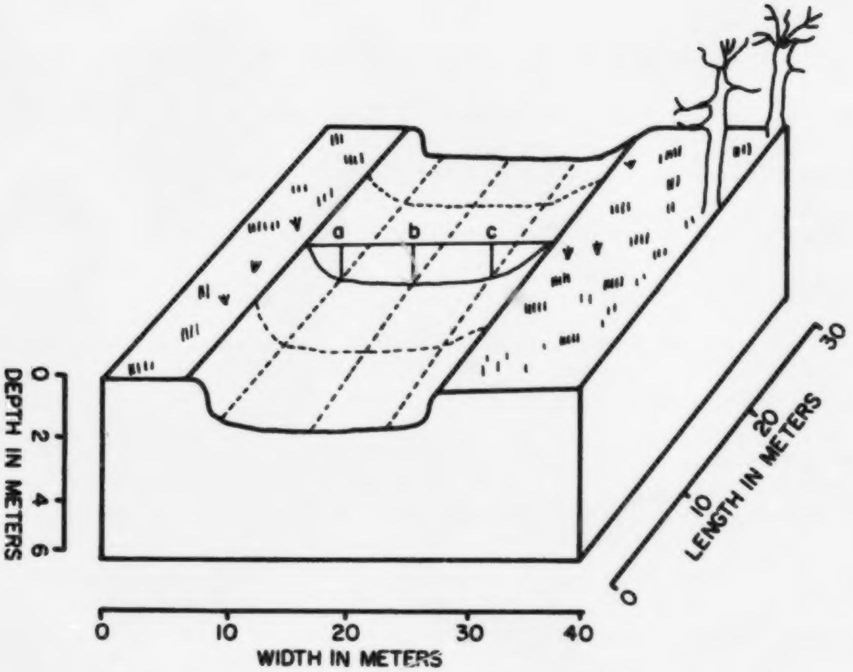
Highway 840A paralleled the canal on the western side. On the eastern shore, terrestrial vegetation was dominated by willows. Undergrowth consisted of grasses, sedges and rushes. Further east the forest type was dominated by cypress.

STATION 28

The sampling site was a 15 meter quadrat in the Cypress Swamp. Fifty meters south of the sample quadrat, the Cypress Swamp was drained by Turner's Slough. The slough joined the Tamiami Canal and passed under U. S. Highway 41 as it continued to drain southward to the Everglades National Park.

A-10a

FIGURE A-11
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 27


a
b
c
DEPTH IN METERS
0
2
4
6
0
10
20
30
40
WIDTH IN METERS
LENGTH IN METERS
0
10
20
30

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a		L	A	L
b		M	A	L
c		L	A	L

KEY

A Abundant Component - Greater Than 40%
L Less Abundant Component - 10 to 40%
M Minor Component - Less Than 10%

In addition to cypress, there were willow and red maple in the area on slightly elevated ground. Various airplants and ferns dominated the understory greenery (Figure A-12).

STATION 29

The station was in the Tamiami Canal. The site was located adjacent to Bridge No. 100 on U. S. Highway 41. The canal was 6 meters wide and had a maximum, mid-channel depth of 2.6 meters. A deposit of detritus and clay covered the limestone channel bottom. Exposed rock was observed along both shorelines (Figure A-13).

A tourist attraction called Orchid Isles was located one hundred meters south of the station (across U. S. Highway 41). The canal was heavily fished but no other nearby land use was evident.

Jet training flights passed over the sample site at 15 minute intervals during the 4-hour biological sampling period. The Dade/Collier Jetport was less than 10 miles east of Station 29.

STATION 32

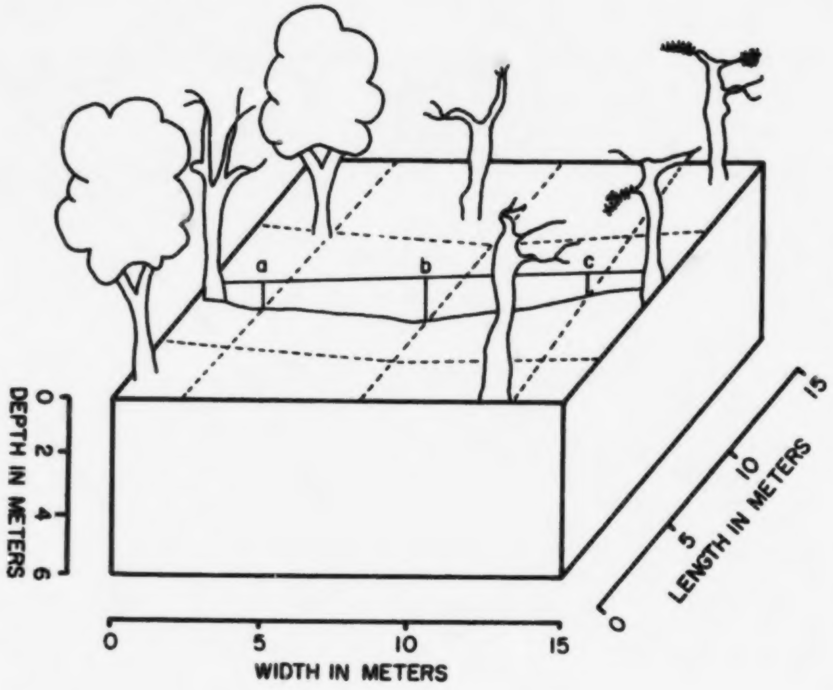
The station was a 0.3 acre cypress pond in the Fakahatchee Strand. It was located 1.7 miles west of Florida Highway 29 and 0.8 mile south of Alligator Alley.

The pond was formed during removal of spoil for a nearby abandoned logging road. Maximum water depth was 2.9 meters. The limestone base was overlain with a thick deposit of clay and detritus (Figure A-14).

Nearby land uses seemed restricted to hunting and/or fishing. Road access was limited most of the year except to all terrain vehicle types (ATV's).

A-11a

FIGURE A-12
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 28


a
b
c
DEPTH IN METERS
0
2
4
6
0
5
10
15
WIDTH IN METERS
LENGTH IN METERS
0
5
10
15

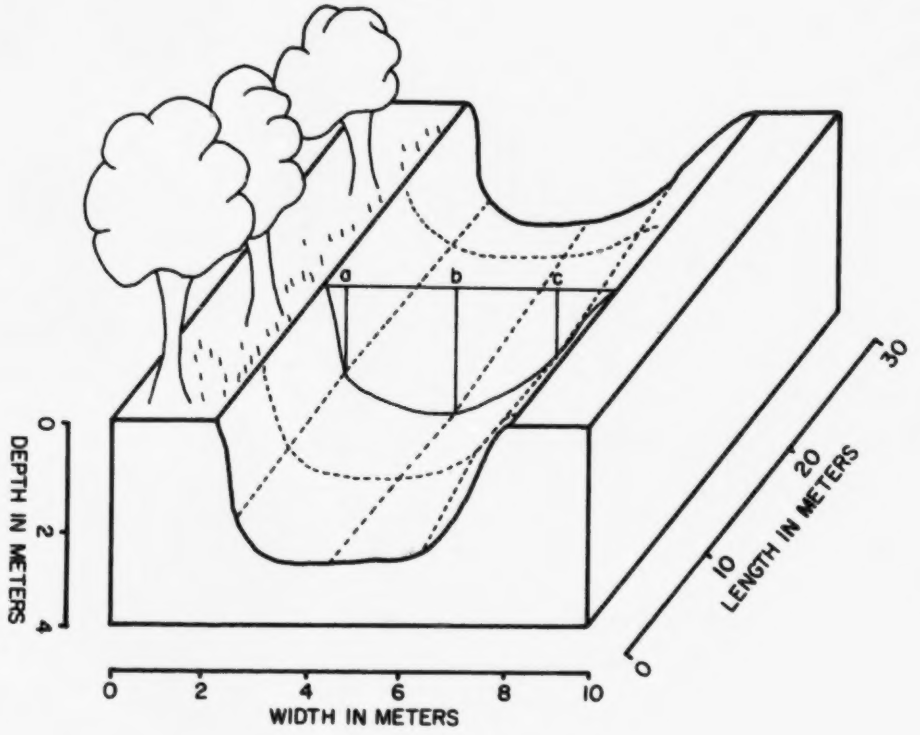
BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	A	L		
b	A	L		
c	A	L		

KEY

- A Abundant Component - Greater Than 40 %
- L Less Abundant Component - 10 to 40 %
- M Minor Component - Less Than 10 %

A-11t

FIGURE A-13
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 29



a
b
c
DEPTH IN METERS
0
2
4
0
2
4
6
8
10
WIDTH IN METERS
0
10
20
30
LENGTH IN METERS

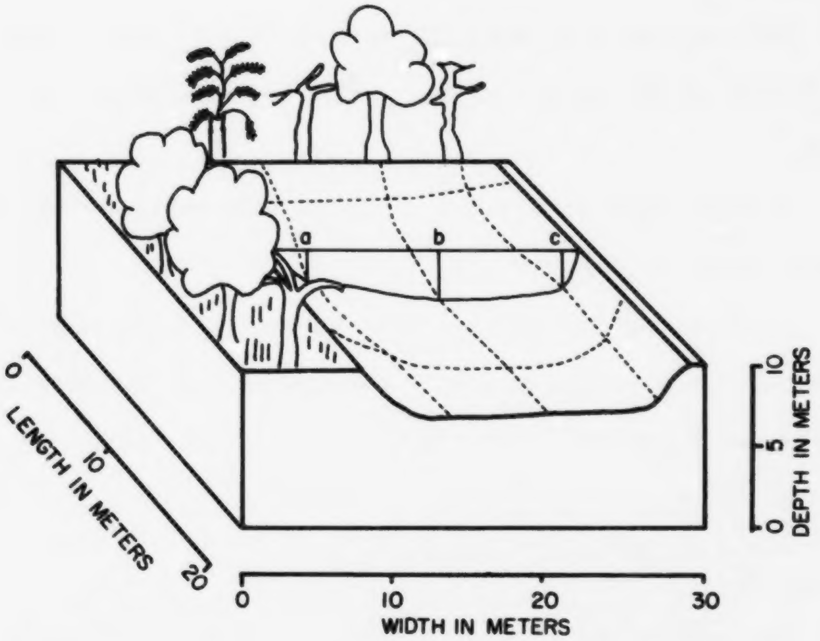
BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	A	L		L
b	A	L		M
c	A	L		L

KEY

A Abundant Component - Greater Than 40 %
L Less Abundant Component - 10 to 40 %
M Minor Component - Less Than 10 %

A-11c

FIGURE A-14
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 32



a
b
c
0
10
20
LENGTH IN METERS
0
10
20
30
WIDTH IN METERS
0
5
10
DEPTH IN METERS

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	M	A		
b		A		
c	M	A		M

KEY

A Abundant Component - Greater Than 40 %
L Less Abundant Component - 10 to 40 %
M Minor Component - Less Than 10 %

The pond shoreline was shaded by a forest of magnolia, willow, cypress, maple, and some scattered palms. The understory was a mixed grass-sedge growth with mint, ferns and wild aster intermingled.

STATION 33

The sampling site was a 20-meter quadrat in a wet prairie. The prairie was located in the middle of Fakahatchee Strand, 0.8 mile south of Alligator Alley.

Maximum water depth was 0.2 meters. The substrate was peat and soft organic detritus (Figure A-15).

An abandoned logging road provided the only access to this area. Near the western edge of the prairie was a staging area for swamp buggy vehicles. The area land use seemed restricted to hunting or, in sloughs and ponds, fishing.

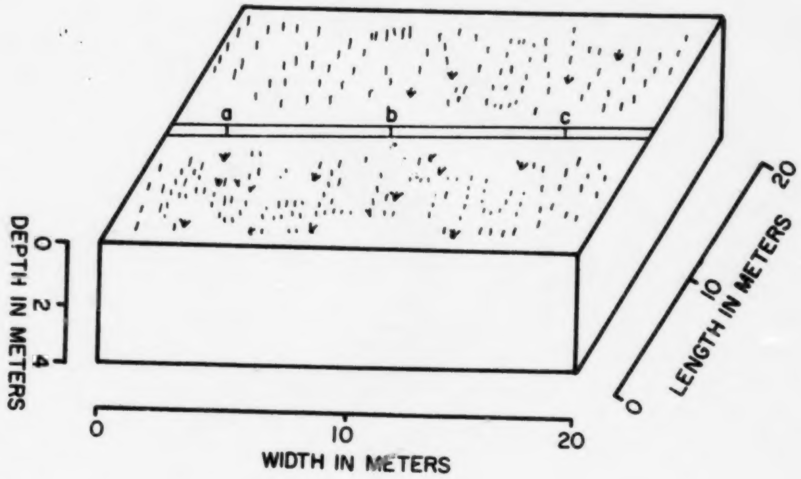
STATION 34

The station was a 20-meter quadrat in a sawgrass marsh. The marsh was located near Conservation Pool No. 3A, 0.1 mile north of Station 5. It was accessible by boat from the canal on the western side of Pool No. 3A.

The substrate was detritus, with an overlying sheet of water approximately 0.5 meters deep (Figure A-16). Occasional dwarf cypress rose above the sawgrass in the marsh. Other vegetation included arrowhead and pickerelweed, and on higher elevations willows and mixed grasses.

The area appeared to be used for hunting, and in the nearby drainage canals fishing was a major use. The station was approximately two miles from the southeast corner of the Dade/Collier Jetport property.

FIGURE A-15
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 33

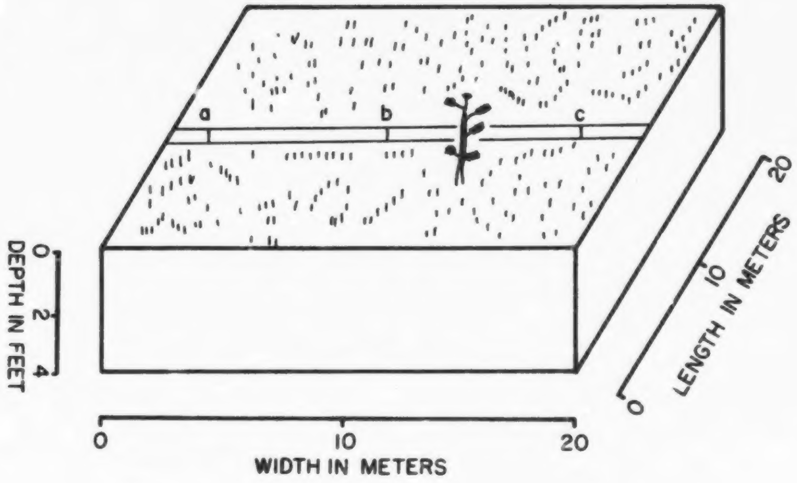

a
b
c
DEPTH IN METERS
0
2
4
LENGTH IN METERS
0
10
20
WIDTH IN METERS
0
10
20

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	A	L		
b	A	L		
c	A	L		

KEY

A Abundant Component - Greater Than 40%
L Less Abundant Component - 10 to 40%
M Minor Component - Less Than 10%

FIGURE A-16
DIAGRAMMATIC TRANSECT AND SEDIMENT COMPOSITION AT STATION 34


a
b
c
DEPTH IN FEET
0
2
4
WIDTH IN METERS
0
10
20
LENGTH IN METERS
0
10
20

BOTTOM COMPOSITION OVERLYING CALCAREOUS BEDROCK				
Sample Site	Detritus	Organo-Clay Complex	Sand	Eroded Limestone
a	A			
b	A			
c	A			

KEY

- A Abundant Component - Greater Than 40%
- L Less Abundant Component - 10 to 40%
- M Minor Component - Less Than 10%

APPENDIX B

BIOLOGICAL STUDY METHODS

Biological sampling stations were located at 33 sites in the Big Cypress Swamp. Nine sites were selected in the GAC Corporation canal system, and 19 other sites in the major drainage canals crossing the eastern, undeveloped sector of the Swamp. Additional biological study sites were established in five other aquatic habitats, including a wet prairie, a sawgrass marsh, a cypress swamp, a slough, and a cypress pond.

In canals, a biological station consisted of a 30 meter transect. In other habitats, quadrats varying in size from 10 to 20 meters were studied. Depth, width and the contour of each study area were determined using a metric measuring tape with a sounding lead. These measurements were used later for diagrammatic drawings of each station.

PLANKTON AND PERIPHYTON

For plankton analysis, surficial grab samples of water were collected in 2-liter largemouth plastic bottles at each station. The samples were preserved with 4 percent formalin and shipped to the Southeast Water Laboratory, Athens, Georgia.

For periphyton analysis, samples were collected at each station on submerged artificial substrates. The substrates consisted of five 1 x 3-inch glass slides held in a clear plastic rack. Racks were submerged at depths of one meter or less. After 3 weeks exposure to the aquatic environment, the periphyton community established on the slides was assumed to have attained an ecological equilibrium. The slide racks were recovered. Four slides were selected for periphyton weight analysis. Individually, these slides were placed into small plastic bottles and allowed to air dry. The remaining slide was kept for taxonomic study of the periphyton. This slide was preserved in 4 percent formalin and stored for later analysis. Upon return to Naples, Florida, field laboratory, the dry slides in their individual bottles were placed in an oven and dried at 60°C for 24 hours. The bottles were removed, sealed, relabeled and stored for later analysis.

At the Southeast Water Laboratory all periphyton and plankton analytical procedures, except the weight analysis, followed the methods described by Weber.(15)

Periphyton weight analysis was determined by an ash-free dry weight method. The dried slides were removed from their sealed bottles, rewet with distilled water, scraped into separate crucibles, and dried at 105°C. This dry weight was recorded. The residue was ignited at 600°C and the ash-free weight recorded. Results were reported as grams of dry and ash-free weight per square meter using the following formula:

$$g/m^2 = \frac{\text{weight per slide (gram)}}{\text{exposed area of slide } (m^2)}$$

MACROINVERTEBRATES

Two procedures were used in collecting invertebrates. First, the benthos were quantitatively collected with a standard unweighted Petersen dredge (0.06m opening). Replicate samples were collected in all substrate types found at a field station (i.e. sand, calcareous rubble, silt, clay, peat, and/or organic detritus). Each sample was emptied into a plastic washtub. The bottom composition was examined and the type substrate recorded. The material was washed through a 30-mesh net and the net residue placed in a white enamel pan. Organisms were collected from the debris, separated into major taxonomic groups and preserved in labeled vials with 70 percent alcohol.

Invertebrates were also collected from aquatic vegetation and examined qualitatively. The vegetation was harvested with a cultivating fork or dip net and placed in a flat-bottomed, white enamel pan. After identification of the plant, the invertebrates were collected and preserved as described above.

In the field laboratory, organisms were counted and identified to the lowest, practical taxonomic level. Quantitative results were recorded as numbers per square meter. Qualitative results were recorded as relative abundance of organisms associated with certain plants. Abundance was determined using the following arbitrary criteria:

number of organisms per plant	relative abundance
1	present
2-5	common
6-25	abundant
over 25	profuse

VERTEBRATE INVENTORY

A list was made of birds observed in the immediate vicinity of each station. The listing was limited to birds seen or heard during the 4-hour biological sampling period.

Although there was no special effort made to collect fish, a list was prepared of those collected or observed during the biological field work. Additional identifications were made by examining the catch of nearby fishermen.

VASCULAR PLANTS

Dominant aquatic and terrestrial plants were identified in the field to the lowest practical taxonomic level. Samples of plants or plant parts were observed for laboratory verification. In order to characterize each station, an estimate of plant density was recorded. This estimate included specific leaf and/or plant counts per square meter for the most common emergent and floating forms.

BACTERIOLOGICAL METHODS

All samples were collected using grab techniques. Samples were collected in sterile glass containers and placed on ice where they were maintained until analysis. All samples were analyzed within five hours of collection.

Most of the 34 sampling sites were sampled on at least eight different days extended over the twenty-six day study period.

Total Coliform Enumeration

All total coliform enumerations were made using the standard membrane filter procedure outlined in Standard Methods(16). This procedure consisted of using M-Endo medium with an incubation temperature of 35° ± 0.5°C for 24 ± 2 hours.

Fecal Coliform Enumeration

All fecal coliform determinations were made using the membrane filter procedure of Geldreich et al(17). This method employs M-FC medium with an incubation (waterbath) temperature of 44.5° ± 0.2°C for 22 ± 2 hours.

Total Plate Counts

The standard plate count procedure outlined in Standard Methods(16) was used to estimate the total bacterial population. The procedure employs a pour plate technique using tryptone glucose extract agar at an incubation temperature of 35° ± 0.5°C for 24 hours.

APPENDIX C

ANALYTICAL DATA

TABLE C-I

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES

STATION NUMBER		DISSOLVED OXYGEN (mg/1)	ALKALINITY (mg/1)	TOTAL HARDNESS (mg/1)	SULFATE (mg/1)	pH (Lab)
1	Maximum	5.7	294	352	69.5	7.6
	Minimum	3.4	199	284	38.5	7.3
	Average	4.1	241	330	59.6	7.5
	No. Samples	8	8	8	8	8
2	Maximum	3.0	294	512	170	7.5
	Minimum	1.2	254	343	11.8	7.1
	Average	1.7	273	453	90	7.2
	No. Samples	8	8	8	8	8
3	Maximum	5.1	281	397	68.3	7.5
	Minimum	1.9	187	260	44.7	7.3
	Average	2.9	217	326	53.8	7.3
	No. Samples	8	8	8	8	8
4	Maximum	4.2	309	390	99.2	7.5
	Minimum	0.2	268	336	44.7	7.2
	Average	2.0	294	374	59.2	7.3
	No. Samples	8	8	8	8	8
5	Maximum	6.3	184	188	<3	7.8
	Minimum	3.4	128	136	<3	7.7
	Average	4.9	147	154	---	7.7
	No. Samples	8	8	8	8	8
6	Maximum	5.3	298	384	68	7.6
	Minimum	2.9	217	252	40.4	7.4
	Average	3.8	274	320	39	7.5
	No. Samples	8	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		DISSOLVED OXYGEN (mg/1)	ALKALINITY (mg/1)	TOTAL HARDNESS (mg/1)	SULFATE (mg/1)	pH (Lab)
7	Maximum	5.1	280	291	17.9	7.6
	Minimum	2.6	87.6	95.6	<3	7.4
	Average	3.4	176	217	---	7.5
	No. Samples	8	8	8	8	8
8	Maximum	4.4	159	168	<3	7.6
	Minimum	1.5	109	117	<3	7.3
	Average	2.5	122	131	---	7.5
	No. Samples	8	8	8	8	8
9	Maximum	4.6	233	250	<3	7.7
	Minimum	1.1	105	120	<3	7.4
	Average	3.6	137	151	---	7.5
	No. Samples	8	8	8	8	8
10	Maximum	5.7	217	239	<3	7.6
	Minimum	0.7	70.2	83.6	<3	7.2
	Average	3.3	104	155	---	7.4
	No. Samples	8	8	8	8	8
11	Maximum	2.7	131	152	6.7	7.3
	Minimum	0.1	58.2	68	<3	7.1
	Average	1.5	81	96	---	7.2
	No. Samples	8	8	8	8	8
12	Maximum	5.9	196	204	<3	7.7
	Minimum	2.1	98	98	<3	7.4
	Average	3.5	124	131	--	7.5
	No. Samples	8	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		DISSOLVED OXYGEN (mg/1)	ALKALINITY (mg/1)	TOTAL HARDNESS (mg/1)	SULFATE (mg/1)	pH (Lab)
13	Maximum	7.1	146	148	<3	7.8
	Minimum	5.4	81.8	91.2	<3	7.5
	Average	6.1	105	111	---	7.7
	No. Samples	8	8	8	8	8
14	Maximum	7.2	139	148	<3	7.9
	Minimum	4.9	85.6	93.2	<3	7.5
	Average	6.1	103	108	---	7.7
	No. Samples	8	8	8	8	8
15	Maximum	7.2	145	152	<3	7.9
	Minimum	4.4	88.4	96	<3	7.6
	Average	6.2	110	116	---	7.8
	No. Samples	8	8	8	8	8
16	Maximum	7.7	207	212	7.6	8.0
	Minimum	4.9	104	108	<3	7.4
	Average	6.4	147	156	---	7.7
	No. Samples	8	8	8	8	8
17	Maximum	5.5	235	256	<3	7.7
	Minimum	1.4	116	126	<3	7.5
	Average	4.4	141	152	---	7.7
	No. Samples	8	8	8	8	8
18	Maximum	7.5	321	396	35.8	7.6
	Minimum	3.7	290	367	23.0	7.1
	Average	4.5	309	382	29.2	7.4
	No. Samples	7	7	7	7	7

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		DISSOLVED OXYGEN (mg/1)	ALKALINITY (mg/1)	TOTAL HARDNESS (mg/1)	SULFATE (mg/1)	pH (Lab)
19	Maximum	4.2	313	319	14.8	7.6
	Minimum	2.1	252	241	8.4	7.3
	Average	3.1	270	283	12.3	7.4
	No. Samples	7	7	7	7	7
20	Maximum	6.8	240	252	<3	8.0
	Minimum	2.7	101	108	<3	7.6
	Average	4.1	164	176	---	7.7
	No. Samples	9	9	9	9	9
21	Maximum	6.0	199	220	<3	7.9
	Minimum	1.8	109	120	<3	7.6
	Average	4.0	148	161	---	7.8
	No. Samples	9	9	9	9	9
22	Maximum	6.3	246	267	9.2	8.0
	Minimum	1.7	124	130	<3	7.6
	Average	4.7	165	177	---	7.8
	No. Samples	9	9	9	9	9
23	Maximum	5.7	297	332	24.8	7.7
	Minimum	2.9	219	254	8.4	7.2
	Average	4.1	255	287	13.2	7.5
	No. Samples	9	9	9	9	9
24	Maximum	6.1	232	248	<3	7.7
	Minimum	2.9	105	112	<3	7.6
	Average	4.7	157	168	---	7.7
	No. Samples	9	9	9	9	9

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		DISSOLVED OXYGEN (mg/1)	ALKALINITY (mg/1)	TOTAL HARDNESS (mg/1)	SULFATE (mg/1)	pH (Lab)
25	Maximum	6.3	234	268	18.8	7.9
	Minimum	3.0	104	112	<3	7.6
	Average	4.7	161	173	---	7.7
	No. Samples	9	9	9	9	9
26	Maximum	7.7	227	236	<3	7.9
	Minimum	2.1	114	120	<3	7.7
	Average	6.1	139	146	---	7.7
	No. Samples	8	8	8	8	8
27	Maximum	6.6	218	232	<3	7.8
	Minimum	0.2	90.2	92.8	<3	7.6
	Average	5.0	123	129	---	7.7
	No. Samples	8	8	8	8	8
28	Maximum	5.3	217	229	<3	7.7
	Minimum	1.9	112	116	<3	7.4
	Average	4.0	141	153	3	7.6
	No. Samples	8	8	8	8	8
29	Maximum	6.4	158	164	<3	7.8
	Minimum	0.6	124	129	<3	7.4
	Average	4.0	137	142	---	7.7
	No. Samples	8	8	8	8	8
30	Maximum	5.8	160	168	<3	7.7
	Minimum	1.1	136	146	<3	7.4
	Average	3.4	145	155	---	7.6
	No. Samples	8	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		DISSOLVED OXYGEN (mg/1)	ALKALINITY (mg/1)	TOTAL HARDNESS (mg/1)	SULFATE (mg/1)	pH (Lab)
31	Maximum	4.0	59.4	75	4.0	7.3
	Minimum	2.1	39.8	70	<3	7.2
	Average	3.2	52	73	---	7.2
	No. Samples	3	3	3	3	3
32	One Sample	---	178	189	<3	7.6
33	One Sample	---	150	162	<3	7.7

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES

STATION NUMBER		pH (Field)	TURBIDITY (JCU)	COLOR UNITS	TEMPERATURE (^oC)	CONDUCTIVITY (μmhos)	NITRATE-N (mg/1)
1	Maximum	7.7	14.0	120	22.5	690	0.30
	Minimum	7.1	5.8	60	20	560	<0.05
	Average	7.3	10.2	109	21	635	---
	No. Samples	8	8	8	8	8	8
2	Maximum	7.3	17	140	21.5	900	0.20
	Minimum	6.8	3.9	100	20	600	<0.05
	Average	7.0	10	119	21	809	--
	No. Samples	8	8	8	8	8	8
3	Maximum	7.3	12	150	22	710	0.80
	Minimum	6.8	7.5	120	20	520	<0.05
	Average	7.1	9	146	21	590	--
	No. Samples	8	8	8	8	8	8
4	Maximum	7.2	53	150	22	720	0.20
	Minimum	6.8	3.8	90	20	620	<0.05
	Average	7.0	30	104	21	748	--
	No. Samples	8	8	8	8	8	8
5	Maximum	7.6	3.4	35	23	420	0.05
	Minimum	7.2	1.8	30	18.5	290	<0.05
	Average	7.4	3.0	31	21	335	--
	No. Samples	5	8	8	8	8	8
6	Maximum	7.7	12	125	22	760	0.10
	Minimum	6.9	5.3	50	20.5	520	<0.05
	Average	7.2	8	68	21	638	---
	No. Samples	8	8	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		pH (Field)	TURBIDITY (JCU)	COLOR UNITS	TEMPERATURE (°C)	CONDUCTIVITY (µmhos)	NITRATE-N (mg/1)
7	Maximum	7.4	13	75	22	590	0.45
	Minimum	7.0	6.6	35	19	240	<0.05
	Average	7.2	8	60	20	451	--
	No. Samples	8	8	8	8	8	8
8	Maximum	7.6	7	60	21.5	390	<0.05
	Minimum	6.9	1.2	50	17	280	<0.05
	Average	7.2	3	57	20	317	--
	No. Samples	8	8	8	8	8	8
9	Maximum	7.5	4.3	90	22	505	0.05
	Minimum	7.1	1.8	50	19	260	<0.05
	Average	7.2	2.8	81	20	326	--
	No. Samples	8	8	8	8	8	8
10	Maximum	7.4	7.2	110	21.5	510	0.15
	Minimum	6.8	0.6	90	18.5	190	<0.05
	Average	6.9	2.1	100	20	273	--
	No. Samples	5	8	8	8	8	8
11	Maximum	7.2	1.3	100	22	380	<0.05
	Minimum	6.5	0.5	90	18.5	190	<0.05
	Average	6.8	0.8	99	20	261	--
	No. Samples	5	8	8	8	8	8
12	Maximum	7.4	4.7	50	22	440	<0.05
	Minimum	6.8	0.6	40	19	220	<0.05
	Average	7.0	1.6	46	20	288	--
	No. Samples	5	8	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		pH (Field)	TURBIDITY (JCU)	COLOR UNITS	TEMPERATURE (^oC)	CONDUCTIVITY (μ mhos)	NITRATE-N (mg/1)
13	Maximum	7.7	4.2	35	23	320	<0.05
	Minimum	6.9	0.6	30	19	190	<0.05
	Average	7.3	2.0	32	21	236	--
	No. Samples	5	8	8	8	8	8
14	Maximum	7.7	8	50	23.5	320	<0.05
	Minimum	6.9	0.9	40	19.5	210	<0.05
	Average	7.3	3	46	21	248	--
	No. Samples	5	8	8	8	8	8
15	Maximum	7.9	6.8	40	24	325	<0.05
	Minimum	7.0	1.6	30	19.5	190	<0.05
	Average	7.4	3.4	36	21	242	--
	No. Samples	5	8	8	8	8	8
16	Maximum	8.0	26	90	22	480	0.25
	Minimum	7.1	1.2	35	19	290	<0.05
	Average	7.4	11	73	20	375	--
	No. Samples	5	8	8	8	8	8
17	Maximum	7.4	6	60	23.5	530	<0.05
	Minimum	7.2	0.9	50	19	270	<0.05
	Average	7.3	2	55	20	323	--
	No. Samples	5	8	8	8	8	8
18	Maximum	7.4	12	60	23.5	960	0.05
	Minimum	6.8	5	50	20	860	<0.05
	Average	7.2	8	54	22	922	--
	No. Samples	6	7	7	7	7	7
19	Maximum	7.4	68	60	23	710	0.15
	Minimum	6.9	0.8	25	20	515	<0.05
	Average	7.1	41	46	22	599	--
	No. Samples	6	7	7	7	7	7

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		pH (Field)	TURBIDITY (JCU)	COLOR UNITS	TEMPERATURE (^{o}C)	CONDUCTIVITY (µmhos)	NITRATE-N (mg/1)
20	Maximum	7.6	8	60	22	550	<0.05
	Minimum	7.1	0.8	40	15	230	<0.05
	Average	7.5	2	52	18	381	--
	No. Samples	8	9	9	9	9	9
21	Maximum	7.9	2.4	40	22.5	530	<0.05
	Minimum	7.2	0.4	30	16	260	<0.05
	Average	7.6	1.4	34	19	364	--
	No. Samples	8	9	9	9	9	9
22	Maximum	7.7	2.2	60	21	600	<0.05
	Minimum	7.3	0.6	35	16	280	<0.05
	Average	7.5	2.0	48	19	381	--
	No. Samples	8	9	9	9	9	9
23	Maximum	7.6	42	60	23	760	0.11
	Minimum	6.9	8.5	30	19	580	<0.05
	Average	7.2	20	42	21	645	--
	No. Samples	8	9	9	9	9	9
24	Maximum	7.7	3.2	60	22	500	0.10
	Minimum	7.3	1.1	50	18.5	230	<0.05
	Average	7.5	1.8	56	20	344	--
	No. Samples	8	9	9	9	9	9
25	Maximum	7.9	3.1	60	23	680	0.10
	Minimum	7.3	1.5	50	17	230	<0.05
	Average	7.6	2.0	56	20	372	--
	No. Samples	8	9	9	9	9	9

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		pH (Field)	TURBIDITY (JCU)	COLOR UNITS	TEMPERATURE (°C)	CONDUCTIVITY (µmhos)	NITRATE-N (mg/1)
26	Maximum	7.7	14	45	24.5	490	<0.05
	Minimum	7.1	0.8	35	18	250	<0.05
	Average	7.5	4	39	20	301	--
	No. Samples	5	8	8	8	8	8
27	Maximum	7.5	1.5	40	24	470	<0.05
	Minimum	7.1	0.6	30	18	200	<0.05
	Average	7.2	0.9	35	20	268	--
	No. Samples	5	8	8	8	8	8
28	Maximum	7.4	1.1	40	24	430	<0.05
	Minimum	7.0	0.5	25	18	235	<0.05
	Average	7.2	0.8	33	20	289	--
	No. Samples	5	8	8	8	8	8
29	Maximum	7.6	1.0	35	24	380	<0.05
	Minimum	6.9	0.1	25	18	280	<0.05
	Average	7.3	0.8	28	20	310	--
	No. Samples	5	8	8	8	8	8
30	Maximum	7.6	1.4	35	23	3[illegible]0	<0.05
	Minimum	6.9	0.7	30	17	310	<0.05
	Average	7.3	1.0	32	20	325	--
	No. Samples	5	8	8	8	8	8
31	Maximum	7.2	1.5	75	23.5	260	<0.05
	Minimum	6.9	1.2	60	20	210	<0.05
	Average	7.0	1.3	68	21	227	---
	No. Samples	3	3	3	3	3	3
32	One Sample	--	--	45	--	375	<0.05
33	One Sample	--	--	45	--	330	<0.05

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES

STATION NUMBER		AMMONIA-N (mg/1)	ORGANIC-N (mg/1)	TOTAL PHOSPHATE as P (mg/1)	SOLUBLE PHOSPHATE as P (mg/1)	TOTAL COPPER (mg/1)	TOTAL IRON (mg/1)
1	Maximum	0.12	0.09	0.12	0.08	<0.01	2.4
	Minimum	0.03	0.06	0.02	<0.01	<0.01	0.5
	Average	0.08	0.08	0.05	--	--	1.7
	No. Samples	8	8	8	8	8	8
2	Maximum	0.14	1.0	0.05	0.02	<0.01	2.2
	Minimum	0.09	0.7	0.01	<0.01	<0.01	1.5
	Average	0.12	0.9	0.03	--	--	1.7
	No. Samples	8	8	8	8	8	8
3	Maximum	0.15	1.1	0.07	0.04	<0.01	1.7
	Minimum	0.05	0.8	0.02	<0.01	<0.01	1.2
	Average	0.09	0.9	0.05	--	--	1.6
	No. Samples	8	8	8	8	8	8
4	Maximum	0.15	1.2	0.05	0.01	<0.01	7.2
	Minimum	0.06	0.7	0.02	<0.01	<0.01	3.8
	Average	0.11	0.9	0.04	--	--	4.7
	No. Samples	8	8	8	8	8	8
5	Maximum	0.19	1.0	0.03	0.01	<0.01	0.04
	Minimum	0.05	0.6	< 0.01	<0.01	<0.01	0.02
	Average	0.12	0.7	--	--	--	0.03
	No. Samples	8	8	8	8	8	8
6	Maximum	0.14	1.0	0.02	<0.01	<0.01	1.6
	Minimum	0.03	0.5	0.01	<0.01	<0.01	0.6
	Average	0.06	0.7	0.02	--	--	0.9
	No. Samples	8	8	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		AMMONIA-N (mg/1)	ORGANIC-N (mg/1)	TOTAL PHOSPHATE as P (mg/1)	SOLUBLE PHOSPHATE as P (mg/1)	TOTAL COPPER (mg/1)	TOTAL IRON (mg/1)
7	Maximum	0.08	0.9	0.13	0.10	< 0.01	0.07
	Minimum	0.03	0.3	0.01	< 0.01	< 0.01	0.02
	Average	0.05	0.7	0.06	--	--	0.05
	No. Samples	8	8	8	8	8	8
8	Maximum	0.04	1.0	0.02	0.02	< 0.01	0.02
	Minimum	0.02	0.6	0.01	< 0.01	< 0.01	0.01
	Average	0.03	0.7	0.02	--	--	0.02
	No. Samples	8	8	8	8	8	8
9	Maximum	0.09	1.2	0.06	0.04	< 0.01	0.7
	Minimum	0.02	0.6	0.03	0.01	< 0.01	0.1
	Average	0.04	0.9	0.05	0.03	--	0.3
	No. Samples	8	8	8	8	8	8
10	Maximum	0.12	1.2	0.10	0.08	< 0.01	1.4
	Minimum	0.02	0.6	0.04	0.02	< 0.01	0.2
	Average	0.04	0.9	0.07	0.05	--	0.4
	No. Samples	8	8	8	8	8	8
11	Maximum	0.05	1.2	0.04	0.04	< 0.01	0.02
	Minimum	0.01	0.8	0.02	0.02	< 0.01	0.01
	Average	0.03	1.0	0.03	0.02	--	0.02
	No. Samples	8	8	8	8	8	8
12	Maximum	0.05	1.6	0.13	0.03	< 0.01	0.01
	Minimum	0.02	0.6	0.02	< 0.01	< 0.01	< 0.01
	Average	0.04	0.8	0.04	--	--	--
	No. Samples	8	8	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		AMMONIA-N (mg/1)	ORGANIC-N (mg/1)	TOTAL PHOSPHATE as P (mg/1)	SOLUBLE PHOSPHATE as P (mg/1)	TOTAL COPPER (mg/1)	TOTAL IRON (mg/1)
13	Maximum	0.07	1.0	0.06	0.02	<0.01	<0.01
	Minimum	0.02	0.5	<0.01	<0.01	<0.01	<0.01
	Average	0.04	0.7	--	--	--	--
	No. Samples	8	8	8	8	8	8
14	Maximum	0.03	0.8	0.03	0.01	<0.01	0.01
	Minimum	0.02	0.5	0.01	<0.01	<0.01	<0.01
	Average	0.03	0.7	0.02	--	--	--
	No. Samples	8	8	8	8	8	8
15	Maximum	0.06	0.09	0.03	0.02	<0.01	0.02
	Minimum	0.03	0.05	0.01	<0.01	<0.01	<0.01
	Average	0.04	0.07	0.02	--	--	--
	No. Samples	8	8	8	8	8	8
16	Maximum	0.10	1.0	0.12	0.07	<0.01	0.05
	Minimum	0.02	0.8	0.02	<0.01	<0.01	0.03
	Average	0.05	0.9	0.07	--	--	0.04
	No. Samples	8	8	8	8	8	8
17	Maximum	0.07	0.07	0.08	0.02	<0.01	0.3
	Minimum	0.02	0.06	0.02	<0.01	<0.01	<0.1
	Average	0.03	0.06	0.03	--	--	--
	No. Samples	8	8	8	8	8	8
18	Maximum	0.11	0.07	0.03	0.01	<0.01	0.9
	Minimum	0.02	0.05	0.01	<0.01	<0.01	0.5
	Average	0.07	0.06	0.02	--	--	0.8
	No. Samples	7	7	7	7	7	7

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		AMMONIA-N (mg/1)	ORGANIC-N (mg/1)	TOTAL PHOSPHATE as P (mg/1)	SOLUBLE PHOSPHATE as P (mg/1)	TOTAL COPPER (mg/1)	TOTAL IRON (mg/1)
19	Maximum	0.10	0.09	0.15	0.03	<0.01	1.3
	Minimum	0.06	0.04	0.02	<0.01	<0.01	0.2
	Average	0.08	0.06	0.09	--	--	0.8
	No. Samples	7	7	7	7	7	7
20	Maximum	0.05	0.7	0.02	0.01	<0.01	0.2
	Minimum	0.01	0.4	0.01	<0.01	<0.01	<0.1
	Average	0.02	0.6	0.02	--	--	--
	No. Samples	9	9	9	9	9	9
21	Maximum	0.05	0.7	0.03	0.01	<0.01	0.1
	Minimum	0.01	0.4	< 0.01	<0.01	<0.01	<0.1
	Average	0.02	0.6	--	--	--	--
	No. Samples	9	9	9	9	9	9
22	Maximum	0.04	0.8	0.04	0.02	<0.01	0.2
	Minimum	0.01	0.4	<0.01	<0.01	<0.01	<0.1
	Average	0.02	0.6	--	--	--	--
	No. Samples	9	9	9	9	9	9
23	Maximum	0.07	0.8	0.09	0.02	<0.01	0.6
	Minimum	0.04	0.4	0.04	<0.01	<0.01	0.2
	Average	0.06	0.6	0.05	--	--	0.5
	No. Samples	9	9	9	9	9	9
24	Maximum	0.05	1.3	0.04	0.02	<0.01	0.4
	Minimum	0.02	0.6	0.02	0.01	<0.01	0.1
	Average	0.03	0.7	0.03	0.01	--	0.2
	No. Samples	9	9	9	9	9	9

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		AMMONIA-N (mg/1)	ORGANIC-N (mg/1)	TOTAL PHOSPHATE as P (mg/1)	SOLUBLE PHOSPHATE as P (mg/1)	TOTAL COPPER (mg/1)	TOTAL IRON (mg/1)
25	Maximum	0.05	1.0	0.06	0.01	<0.01	0.4
	Minimum	0.02	0.5	0.02	<0.01	<0.01	<0.1
	Average	0.03	0.7	0.03	--	--	--
	No. Samples	9	9	9	9	9	9
26	Maximum	0.03	1.2	0.02	<0.01	<0.01	0.3
	Minimum	0.01	0.5	0.01	<0.01	<0.01	<0.1
	Average	0.02	0.7	0.02	--	--	--
	No. Samples	8	8	8	8	8	8
27	Maximum	0.03	0.6	0.02	0.01	<0.01	0.2
	Minimum	0.01	0.4	0.01	<0.01	<0.01	<0.1
	Average	0.02	0.5	0.02	--	--	--
	No. Samples	8	8	8	8	8	8
28	Maximum	0.26	0.6	0.08	0.04	<0.01	0.4
	Minimum	0.01	0.4	0.01	<0.01	<0.01	<0.01
	Average	0.05	0.5	0.03	--	--	--
	No. Samples	8	8	8	8	8	8
29	Maximum	1.3	1.3	0.38	0.16	<0.01	<0.01
	Minimum	0.02	0.6	0.01	<0.01	<0.01	<0.01
	Average	0.19	0.8	0.07	--	--	--
	No. Samples	8	8	8	8	8	8
30	Maximum	0.71	1.4	0.15	0.10	<0.01	0.1
	Minimum	0.02	0.6	0.02	<0.01	<0.01	<0.1
	Average	0.12	0.8	0.04	--	--	--
	No. Samples	8	8	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		AMMONIA-N (mg/1)	ORGANIC-N (mg/1)	TOTAL PHOSPHATE as P (mg/1)	SOLUBLE PHOSPHATE as P (mg/1)	TOTAL COPPER (mg/1)	TOTAL IRON (mg/1)
31	Maximum	0.04	0.9	0.02	0.01	<0.01	0.02
	Minimum	0.03	0.8	0.01	<0.01	<0.01	0.01
	Average	0.03	0.8	0.01	--	--	0.02
	No. Samples	3	3	3	3	3	3
32	One Sample	0.06	0.6	0.04	0.01	<0.01	0.2
33	One Sample	0.07	1.0	0.12	0.05	<0.01	0.2

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES

STATION NUMBER		TOTAL MANGANESE (mg/1)	TOTAL ORGANIC CARBON (mg/1)	INORGANIC CARBON (mg/1)	TOTAL CARBON (mg/1)
1	Maximum	0.04	20	74	90
	Minimum	<0.02	<1	54	54
	Average	--	13	64	76
	No. Samples	8	8	8	8
2	Maximum	0.04	16	76	89
	Minimum	0.02	1	68	70
	Average	0.03	6	73	79
	No. Samples	8	8	8	8
3	Maximum	0.04	21	74	78
	Minimum	0.02	4	50	55
	Average	0.02	12	58	71
	No. Samples	8	8	8	8
4	Maximum	0.04	25	87	98
	Minimum	0.02	<1	66	72
	Average	0.03	9.5	79	88
	No. Samples	8	8	8	8
5	Maximum	0.02	11	50	55
	Minimum	<0.02	<1	34	40
	Average	--	6	39	45
	No. Samples	8	8	8	8
6	Maximum	0.04	15	83	87
	Minimum	<0.02	<1	57	60
	Average	--	5	73	77
	No. Samples	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		TOTAL MANGANESE (mg/1)	TOTAL ORGANIC CARBON (mg/1)	INORGANIC CARBON (mg/1)	TOTAL CARBON (mg/1)
7	Maximum	0.02	13	64	73
	Minimum	<0.02	6	24	35
	Average	--	9	50	59
	No. Samples	8	8	8	8
8	Maximum	0.02	18	44	51
	Minimum	<0.02	7	30	40
	Average	--	12	34	46
	No. Samples	8	8	8	8
9	Maximum	0.10	23	64	64
	Minimum	<0.02	<1	26	42
	Average	--	14	37	54
	No. Samples	8	8	8	8
10	Maximum	0.03	24	59	62
	Minimum	<0.02	3	19	36
	Average	--	18	28	45
	No. Samples	8	8	8	8
11	Maximum	0.02	24	35	53
	Minimum	<0.02	16	16	32
	Average	--	20	22	41
	No. Samples	8	8	8	8
12	Maximum	0.02	14	52	59
	Minimum	<0.02	7	24	37
	Average	--	10	33	43
	No. Samples	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		TOTAL MANGANESE (mg/1)	TOTAL ORGANIC CARBON (mg/1)	INORGANIC CARBON (mg/1)	TOTAL CARBON (mg/1)
13	Maximum	0.03	14	38	43
	Minimum	<0.02	5	22	31
	Average	--	9	28	37
	No. Samples	8	8	8	8
14	Maximum	0.02	13	37	43
	Minimum	<0.02	6	24	30
	Average	--	10	28	39
	No. Samples	8	8	8	8
15	Maximum	0.02	14	38	43
	Minimum	<0.02	5	24	34
	Average	--	9	29	39
	No. Samples	8	8	8	8
16	Maximum	0.02	15	54	64
	Minimum	<0.02	1	31	42
	Average	--	10	41	52
	No. Samples	8	8	8	8
17	Maximum	0.02	19	62	65
	Minimum	<0.02	3	31	39
	Average	--	10	38	48
	No. Samples	8	8	8	8
18	Maximum	0.04	14	87	95
	Minimum	<0.02	4	78	82
	Average	--	8	83	91
	No. Samples	7	7	6	6

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		TOTAL MANGANESE (mg/1)	TOTAL ORGANIC CARBON (mg/1)	INORGANIC CARBON (mg/1)	TOTAL CARBON (mg/1)
19	Maximum	0.04	8	78	79
	Minimum	<0.02	<1	61	64
	Average	--	3	67	70
	No. Samples	7	7	7	7
20	Maximum	0.02	11	64	70
	Minimum	<0.02	2	27	32
	Average	--	6	44	50
	No. Samples	9	9	9	9
21	Maximum	0.02	11	51	60
	Minimum	<0.02	3	29	40
	Average	--	6	39	45
	No. Samples	9	9	9	9
22	Maximum	0.02	14	65	70
	Minimum	<0.02	3	33	38
	Average	--	6	43	50
	No. Samples	9	9	9	9
23	Maximum	0.08	8	78	86
	Minimum	<0.02	<1	58	58
	Average	--	3	67	70
	No. Samples	9	9	9	9
24	Maximum	0.04	11	62	65
	Minimum	<0.02	<1	30	34
	Average	--	6	41	47
	No. Samples	9	9	9	9

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		TOTAL MANGANESE (mg/1)	TOTAL ORGANIC CARBON (mg/1)	INORGANIC CARBON (mg/1)	TOTAL CARBON (mg/1)
25	Maximum	0.02	9	62	66
	Minimum	<0.02	<1	27	34
	Average	--	6	43	48
	No. Samples	9	9	9	9
26	Maximum	0.02	10	60	60
	Minimum	<0.02	<1	31	35
	Average	--	6	37	43
	No. Samples	8	8	8	8
27	Maximum	<0.02	13	57	66
	Minimum	<0.02	3	23	30
	Average	--	7	33	41
	No. Samples	8	8	8	8
28	Maximum	0.10	10	59	60
	Minimum	<0.02	1	30	34
	Average	--	5	38	43
	No. Samples	8	8	8	8
29	Maximum	0.05	15	42	57
	Minimum	<0.02	4	34	38
	Average	--	8	37	45
	No. Samples	8	8	8	8
30	Maximum	0.23	15	43	58
	Minimum	<0.02	1	36	39
	Average	--	8	40	47
	No. Samples	8	8	8	8

SUMMARY OF PHYSICAL AND CHEMICAL ANALYTICAL RESULTS FROM DAILY SAMPLES (Cont'd)

STATION NUMBER		TOTAL MANGANESE (mg/1)	TOTAL ORGANIC CARBON (mg/1)	INORGANIC CARBON (mg/1)	TOTAL CARBON (mg/1)
31	Maximum	< 0.02	20	17	34
	Minimum	< 0.02	17	14	34
	Average	--	19	15	34
	No. Samples	3	3	3	3
32	One Sample	0.04	4	47	51
33	One Sample	< 0.02	7	40	47

TABLE C-II

SPECIAL INORGANIC ANALYSES

STATION NUMBER	DATE 1970	TOTAL DISSOLVED SOLIDS (mg/l)	CHLORIDE (mg/l)
	March		
1	13	407	22
	23	478	28
	25	482	33
2	13	712	20
	23	656	22
	23	671	22
3	13	374	24
	23	408	25
	25	411	25
4	13	444	21
	23	489	20
	25	501	18
5	12	200	19
	20	190	15
	24	173	15
6	13	368	28
	23	432	25
	25	416	21
7	13	164	20
	23	291	25
	25	303	26
8	13	202	30
	23	194	26
	25	194	27
9	13	188	18
	23	194	23
	25	210	24
10	13	140	16
	23	176	24
	25	164	26

TABLE C-II CONT'D

SPECIAL INORGANIC ANALYSES

STATION NUMBER	DATE 1970	TOTAL DISSOLVED SOLIDS (mg/1)	CHLORIDE (mg/1)
	March		
11	13	164	23
	23	173	40
	25	190	43
12	13	154	15
	23	187	18
	25	197	19
13	13	126	10
	23	150	12
	25	153	12
14	13	156	14
	23	159	16
	25	166	16
15	13	138	11
	23	156	12
	25	164	13
16	13	208	16
	23	312	27
	25	268	29
17	12	178	16
	20	182	16
	24	194	19
18	16	587	104
	20	606	120
	24	594	114
19	16	334	37
	20	327	32
	24	346	39
20	12	160	12
	20	269	14
	24	265	33

TABLE C-II CONT'D.

SPECIAL INORGANIC ANALYSES

STATION NUMBER	DATE 1970	TOTAL DISSOLVED SOLIDS (mg/1)	CHLORIDE (mg/1)
	March		
21	12	176	14
	20	227	25
	24	234	26
22	12	212	22
	20	251	30
	24	209	16
23	12	364	42
	20	381	55
	24	388	53
24	12	346	10
	20	198	13
	24	269	19
25	12	156	11
	20	208	12
	24	244	16
26	12	162	12
	20	180	13
	24	190	15
27	12	156	14
	20	155	11
	24	200	12
28	12	158	8
	20	173	9
	24	170	12
29	12	192	13
	20	187	17
	24	187	19
30	12	226	16
	20	192	12
	24	199	15
31	25	150	32

TABLE C-III
SPECTROGRAPHIC ANALYSIS RESULTS
(IN MICROGRAMS PER LITER)

STATION NUMBER	ZINC	CADMIUM	ARSENIC	BORON	IRON	MOLYBDENUM	MANGANESE	ALUMINUM
1	44	< 10	<50	135	2000	<20	22	175
2	35	< 10	<50	98	1100	<20	24	120
3	36	< 10	<50	110	1100	<20	17	96
4	64	14	<50	115	8000	<20	32	230
5	12	< 10	<50	110	190	<20	7.5	58
6	66	< 10	<50	81	700	<20	22	170
7	41	< 10	<50	43	390	<20	14	150
8	43	< 10	<50	75	190	<20	11	130
9	40	< 10	<50	56	300	<20	24	100
10	10	< 10	<50	38	190	<20	4.8	< 20
11	<10	< 10	<50	100	115	<20	6.0	< 20
12	<10	< 10	<50	39	34	<20	7.5	24
13	<10	< 10	<50	29	23	<20	5.8	27
14	<10	< 10	<50	160	38	<20	5.0	48
15	18	< 10	<50	200	68	<20	9.0	140
16	17	< 10	<50	81	350	<20	13	210
17	<10	< 10	<50	33	61	<20	4.3	< 20
18	70	< 10	<50	77	600	<20	27	235
19	32	< 10	<50	52	930	<20	22	3300
20	20	< 10	<50	108	84	<20	19	53
21	44	< 10	<50	39	75	<20	8.3	170
22	46	< 10	<50	49	108	<20	11	112
23	44	< 10	<50	110	630	<20	33	1600
24	54	< 10	<50	130	130	<20	10	108
25	24	< 10	<50	135	100	<20	7.0	58
26	<10	< 10	<50	36	33	<20	4.0	25
27	<10	< 10	<50	17	21	<20	<4.0	< 20
28	18	< 10	<50	100	33	<20	5.5	83
29	<10	< 10	<50	30	32	<20	5.5	55
30	<10	< 10	<50	26	26	<20	<4.0	29

SPECTROGRAPHIC ANALYSIS RESULTS (CONT'D)
(IN MICROGRAMS PER LITER)

STATION NUMBER	BERYLLIUM	COPPER	SILVER	NICKEL	COBALT	LEAD	CHROMIUM
1	0.12	<25	<1.0	<10	11	60	8
2	0.14	<25	<1.0	13	17	110	19
3	0.12	<25	<1.0	11	15	110	15
4	0.15	<25	<1.0	16	17	130	20
5	<0.10	<25	<1.0	<10	<10	20	6
6	0.15	<25	<1.0	17	17	170	23
7	0.10	25	1.0	15	19	140	9
8	<0.10	<25	<1.0	<10	10	115	11
9	<0.10	<25	<1.0	<10	<10	110	11
10	<0.10	<25	<1.0	<10	<10	< 20	< 4
11	<0.10	<25	<1.0	<10	<10	< 20	7
12	<0.10	<25	<1.0	<10	<10	48	11
13	<0.10	<25	<1.0	<10	<10	30	8
14	<0.10	<25	<1.0	<10	<10	< 20	6
15	<0.10	<25	<1.0	<10	10	55	12
16	<0.10	<25	<1.0	13	17	50	17
17	<0.10	<25	<1.0	<10	<10	< 20	< 4
18	0.15	<25	<1.0	14	17	130	22
19	0.15	<25	<1.0	22	25	190	30
20	<0.10	<25	<1.0	<10	<10	80	10
21	<0.10	<25	<1.0	<10	<10	160	11
22	<0.10	<25	<1.0	10	<10	130	14
23	0.15	<25	<1.0	24	24	200	31
24	0.10	<25	<1.0	11	13	145	15
25	<0.10	<25	<1.0	<10	12	64	14
26	<0.10	<25	<1.0	<10	<10	< 20	9
27	<0.10	<25	<1.0	<10	<10	< 20	4
28	<0.10	<25	<1.0	12	14	70	15
29	<0.10	<25	<1.0	<10	10	35	10
30	<0.10	<25	<1.0	<10	<10	< 20	5

SPECTROGRAPHIC ANALYSIS RESULTS (CONT'd)
(IN MICROGRAMS PER LITER)

STATION NUMBER	VANADIUM	BARIUM	STRONTIUM
1	<20	18	310
2	24	18	235
3	21	12	155
4	26	27	310
5	<20	11	180
6	30	20	270
7	28	11	94
8	<20	12	130
9	<20	12	74
10	<20	18	45
11	<20	16	38
12	<20	11	62
13	<20	10	46
14	<20	11	80
15	<20	17	140
16	22	15	150
17	<20	10	53
18	26	22	500
19	38	22	150
20	<20	8	54
21	<20	10	110
22	20	11	98
23	40	24	245
24	22	13	78
25	<20	10	45
26	<20	10	54
27	<20	5	30
28	<20	8	88
29	<20	10	110
30	<20	8	87

AN ANNOTATED LIST OF ALGAE COLLECTED IN
VARIOUS HABITATS OF THE BIG CYPRESS SWAMP, FLORIDA
MARCH 1970

Phylum Chlorophyta
Subdivision Chlorophyceae

Volvocales.

The GAC Corporation (GAC) Canal System, Alligator Alley Canal, Tamiami Trail Canal, and 840A Canal. Present in periphyton and as plankton at Stations 5,6,8,12,13,17 and 27.

Family Chlamydomonadaceae

Chlamydomonas sp.

GAC Canal System and Alligator Alley Canal. Present in periphyton and as plankton at Stations 6, 7 and 8.

Family Volvocaceae

Eudorina sp.

Highway 840A Canal. Present in periphyton at Station 27.

Pandorina spp.

Alligator Alley Canal, Tamiami Trail Canal and Highway 840A Canal. Common as plankton at Stations 5, 12, 13 and 17.

Order Tetrasporales
Family Palmellaceae

Palmella sp.

GAC Canal System, Alligator Alley Canal and Fakahatchee Strand. Present in periphyton at Stations 8, 20 and 23.

Ulotrichales.

GAC Canal System, Highway 29 and 840A Canals, Fakahatchee Strand, cypress slough, cypress swamp and pond. Present in periphyton at Stations 1,2,3,10,11,17,19,20,21 and 32.

Family Ulotrichaceae

Ulothrix sp.

Cypress swamp and Highway 840A Canal. Present in periphyton at Stations 27 and 28.

Family Chaetophoraceae

Chaetopeltis sp.
Tamiami Trail Canal, Highway 840A Canal and Fakahatchee Strand. Common in periphyton at Stations 20, 27 and 29.

Stigeoclonium sp.
Tamiami Trail Canal and Highway 840A Canal and cypress swamp. Common in periphyton at Stations 27, 28 and 29.

Family Protococcaceae

Protococcus sp.
Alligator Alley Canal. Common in periphyton at Stations 8, 13 and 15.

Family Coleochaetaceae

Coleochaete sp.
Tamiami Trail Canal, Highway 840A Canal, cypress swamp and Fakahatchee Strand. Common in periphyton and present as plankton at Stations 20, 27, 28 and 29.

Order Cladophorales

Family Cladophoraceae

Cladophora sp.
Highway 840A Canal. Common as periphyton at Station 27.

Rhizoclonium sp.
Cypress slough, cypress swamp and pond. Common in periphyton at Stations 21, 28 and 32.

Order Oedogoniales

Family Oedogoniaceae

Bulbochaeta sp.
Highway 840A Canal and Fakahatchee Strand. Present in periphyton at Stations 20 and 27.

Oedogonium sp.
Highway 840A Canal and Fakahatchee Strand. Present in periphyton at Stations 20 and 27.

Order Chlorococcales
Family Chlorococcaceae

Chlorococcum sp.
Alligator Alley Canal. Present as plankton at Station 14.

Golenkinia sp.
GAC Canal System and Tamiami Trail Canal. Common as plankton at Stations 1 and 5.

Family Botryococcaceae

Botryococcus sp.
GAC Canal System and Fakahatchee Strand. Present in periphyton at Stations 7, 18 and 20.

Family Hydrodictyaceae

Pediastrum spp.
Alligator Alley Canal, Tamiami Trail Canal and Highway 840A Canal. Present in periphyton and as plankton at Stations 5,8,13,15, 27 and 29.

Family Coelastraceae

Coelastrum sp.
GAC Canal System. Present as plankton at Station 6.

Order Chlorococcales

Oocystaceae.
All canals, Fakahatchee Strand, cypress swamp, pond and sawgrass marsh. Common as plankton and in periphyton.

Ankistrodesmus spp.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal, Highway 29 and Highway 840A Canals. Present in periphyton and common as plankton at all stations in Alligator Alley and 840A Canals and at Stations 1,3,6,9,20,23,28,29, and 30.

Chlorella sp.
Common as plankton and in periphyton at all stations except 19, 25 and 30.

Oocystis spp.
Alligator Alley Canal, Tamiami Trail Canal, Highway 29 and Highway 840A Canals, and cypress swamp. Present in periphyton and as plankton at Stations 9,12,14,17,22,24,28 and 29.

Selenastrum sp.
GAC Canal System and Tamiami Trail Canal. Present in periphyton at Stations 6, 18 and 30.

Tetraedron spp.
Alligator Alley Canal and Highway 29 and Highway 840A Canals. Present in periphyton and as plankton at Stations 8, 9 and 26.

Westella sp.
Highway 29 and Highway 840A Canals and Fakahatchee Strand. Present as plankton and in periphyton at Stations 20, 24 and 27.

Family Scenedesmaceae

Crucigenia spp.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal. Present in periphyton and as plankton at Stations 6,8,13,18,29 and 30.

Scenedesmus spp.
All canals systems, and the cypress swamp. Common as plankton and in periphyton.

Order Zygnematales
Family Zygnemataceae

Mougeotia sp.
GAC Canal System, Alligator Alley Canal, Highway 840A Canal, Fakahatchee Strand and cypress swamp. Common in periphyton at Stations 15,19,20, 26,27 and 28.

Spirogyra spp.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal, Highway 840A Canal, Fakahatchee Strand, cypress swamp and Interceptor Canal No. 28. Present as plankton and abundant in periphyton at Stations 3,7,14,16,20,23,25,27 and 28.

Zygonema sp.
Tamiami Trail Canal, Highway 840A Canal and Fakahatchee Strand. Common in periphyton at Stations 5, 20 and 27.

Family Desmidiaceae

Closterium spp.
Tamiami Trail Canal, Highway 29 and 840A Canals and Alligator Alley Canal. Present in periphyton and as plankton at Stations 5,8,9,24 and 27.

Cosmarium spp.
GAC Canal System, Tamiami Trail Canal, Alligator Alley Canal, Highway 840A Canal and Fakahatchee Strand. Present in periphyton and as plankton at Stations 5,13,14,15,18,20,22,23,25,26,27 and 29.

Euastrum spp.
Tamiami Trail Canal and cypress swamp. Present in periphyton at Stations 28 and 29.

Micrasterias spp.
Alligator Alley Canal and wet prairie. Present in periphyton at Stations 8, 15 and 33.

Staurastrum spp.
Alligator Alley Canal, Tamiami Trail Canal, Highway 840A Canal, cypress swamp and a pond in Fakahatchee Strand. Present in periphyton at Stations 5,14,25,26,27,28,29 and 32.

Family Characeae

Chara sp.
Tamiami Trail Canal. Common in periphyton at Station 5.

Phylum Euglenophyta
Order Euglenales

Euglenaceae
Common in periphyton and as plankton at all stations except 4 and 19.

Phacus sp.
GAC Canal System, Alligator Alley Canal. Present in periphyton and as plankton at Stations 6 and 8.

Trachelomonas sp.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal, Highway 29 Canal and the cypress swamp. Common as plankton and present in periphyton at Stations 4,6,7,10,12,14,18,23,28,29 and 30.

Phylum Pyrrhophyta
Subdivision Desmokontae
Family Peridiniaceae

Peridinium sp.
GAC Canal System. Present as plankton at Station 23.

Dinophyceae.
Present in all canals except Highway 840A Canal.

Order Dinokontae (Dinokontales)
Family Gymnodiniaceae

Gymnodinium sp.
GAC Canal System, Alligator Alley Canal and Tamiami Trail Canal. Present as plankton at Stations 5,12,13,14,18,19,29 and 30.

Phylum Chrysophyta
Subdivision Xanthophyceae
Order Heterococcales
Family Characiopsidaceae

Characiopsis sp.
Tamiami Trail Canal and Highway 840A Canal. Present in periphyton at Stations 27, 29 and 30.

Order Chrysomonadales
Family Ochromonadaceae

Dinobryon sp.
All canals and the wet prairie. Common as plankton at all stations in Alligator Alley and Stations 1,3,4,5,10,16,17,18,24,27 and 33.

Subdivision Xanthophyceae

Centrales.
Common to abundant in periphyton and as plankton in all habitats except the wet prairie.

Family Coscinodiscaceae

Melosira spp.
GAC Canal System, Alligator Alley Canal, Highway 840A Canal, cypress swamp and pond. Common as plankton and in periphyton at Stations 7, 8,27,28 and 32.

Phylum Pyrrhophyta
Subdivision Desmokontae
Family Peridiniaceae

Peridinium sp.
GAC Canal System. Present as plankton at Station 23.

Dinophyceae.
Present in all canals except Highway 840A Canal.

Order Dinokontae (Dinokontales)
Family Gymnodiniaceae

Gymnodinium sp.
GAC Canal System, Alligator Alley Canal and Tamiami Trail Canal. Present as plankton at Stations 5,12,13,14,18,19,29 and 30.

Phylum Chrysophyta
Subdivision Xanthophyceae
Order Heterococcales
Family Characiopsidaceae

Characiopsis sp.
Tamiami Trail Canal and Highway 840A Canal. Present in periphyton at Stations 27, 29 and 30.

Order Chrysomonadales
Family Ochromonadaceae

Dinobryon sp.
All canals and the wet prairie. Common as plankton at all stations in Alligator Alley and Stations 1,3,4,5,10,16,17,18,24,27 and 33.

Subdivision Xanthophyceae

Centrales.
Common to abundant in periphyton and as plankton in all habitats except the wet prairie.

Family Coscinodiscaceae

Melosira spp.
GAC Canal System, Alligator Alley Canal, Highway 840A Canal, cypress swamp and pond. Common as plankton and in periphyton at Stations 7, 8,27,28 and 32.

Subdivision Xanthophyceae

Pennales.

Common to abundant in periphyton and as plankton in all habitats studied.

Family Fragilariaceae

Asterionella sp.

GAC Canal System. Present as plankton at Station 23.

Family Naviculaceae

Gyrosigma sp.

GAC Canal System. Present in periphyton at Station 7.

Phylum Cyanophyta
Subdivision Myxophyceae

Chroococcales.

Alligator Alley Canal and Tamiami Trail Canal. Present in periphyton and common as plankton at Stations 12,13,15,29 and 30.

Family Chroococcaceae

Anacystis sp.

All canals, cypress swamp and Fakahatchee Strand. Present in periphyton at Stations 1,8,9,11,12,13,18,19,20,24,26,27,28 and 29.

Gomphosphaeria sp.

Highway 840A Canal System. Present in periphyton at Station 17.

Merismopedia spp.

GAC Canal System, Tamiami Trail Canal, Alligator Alley Canal, Highway 840A Canal, Fakahatchee Strand and wet prairie. Present in periphyton at Stations 5,6,12,14,17,18,20,23,26 and 33.

Subdivision Myxophyceae

Hormogonales.

Common in periphyton in all aquatic habitats except the cypress slough and the wet prairie.

Family Oscillatoriaceae

Arthrospira sp.
Highway 840A Canal and Tamiami Trail Canal. Present in periphyton at Stations 26 and 29.

Lyngbya sp.
All canals, Fakahatchee Strand and cypress swamp. Present as periphyton at Stations 3,7,8,9,13,16,20,23,25,27,28,29 and 30.

Oscillatoria sp.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal, Highway 840A Canal, Fakahatchee Strand and cypress swamp. Common as periphyton and occasionally found in plankton at Stations 2,3,4,6,7,8,13,14,15,16, 20,23,27,28,29 and 30.

Spirulina sp.
Tamiami Trail Canal and cypress swamp. Present in periphyton at Stations 28 and 29.

Family Nostocaceae

Anabaena spp.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal, Highway 840A Canal, Fakahatchee Strand and the cypress swamp. Common in periphyton and occasionally as plankton at all stations in Alligator Alley and Tamiami Trail Canals and at Stations 5,11,16,20,22,26,27 and 28.

Nostoc sp.
Highway 840A Canal and cypress slough. Common in periphyton at Stations 17,21 and 27.

AN ANNOTATED LIST OF AQUATIC PLANTS COLLECTED OR OBSERVED IN VARIOUS HABITATS OF THE BIG CYPRESS SWAMP, FLORIDA

MARCH 1970

Kingdom Plant
Division Pteridophyta
Order Hydropteridales
Family Salviniaceae

Azolla caroliniana Wildenow.
Alligator Alley Canal. Water velvet was found floating in sparse patches near the shoreline of Station 14.

Division Spermatophyta
Subdivision Angiospermae
Order Pandanales
Family Typhaceae

Typha augustifolia Linnaeus.
The GAC Corporation Canal System, Alligator Alley Canal, Highway 840A Canal. Narrow-leaf cattail was most common on the shoreline of the GAC Canal System.

Typha latifolia Linnaeus.
Okaloacoochee Slough. Broad-leaf cattail was observed at Station 11 only.

Order Helobiae (Najadales)
Family Zosteraceae

Potamogeton spp.
Highway 840A Canal. Pondweeds were sparse along shoreline of the canal at Station 27.

Family Najadaceae

Najas sp.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal, Highway 840A Canal, Interceptor Canal No. 28, cypress slough, cypress swamp and a pond in Fakahatchee Strand. Naiads were common to abundant and often blanketed the canal bottoms at depths of 2.5 meters (i.e. Station 29).

Family Alismaceae

Sagittaria graminea Michaux.

Alligator Alley Canal, Interceptor Canal No. 28, Highway 840A. Arrowhead was sparse to common along shorelines of Stations 14, 16, 23 and 27.

Sagittaria sp.

Tamiami Trail Canal, Highway 840A Canal, Interceptor Canal No. 28, pond, cypress slough, wet prairie, sawgrass marsh and cypress swamp. Common to abundant along the shorelines of these major habitats. Scattered patches in the prairie and marshes.

Family Hydrocharitaceae

Anacharis sp.

Alligator Alley Canal. Waterweed was sparse along shoreline of Station 14.

Order Glumiflorae (Graminales)
Family Gramineae

Leersia hexandra Swartz.

Cypress slough. This grass was sparse along the margins of Station 21.

Panicum hemitomum Forsk.

GAC Canal System, Tamiami Trail Canal, Okaloacoochee Slough, wet prairie and sawgrass marsh. This grass was sparse to common along canal shorelines. It was abundant in the prairie and marsh.

Family Cyperaceae

Cladium jamacensis Crantz.

Tamiami Trail Canal, pond and sawgrass marsh. Sawgrass was sparse to common along the shoreline of the Tamiami Trail Canal, and the pond. It was the dominant vegetation in the marsh.

Eleocharis spp.

Sawgrass marsh and wet prairie. Spike rush was common in the shallow water of Stations 33 and 34.

Rhyncospora spp.

Wet prairie. Beak rush was one of the three major plant species at Station 33. The other two species in this prairie were *Panicum* and *Eleocharis*.

Order Spathiflorae (Arales)
Family Araceae

Pista stratiotes Linneaus.
GAC Canal System, Highway 840A Canal and Okaloacoochee Slough. Water lettuce was sparse to common in the canals. A dense floating bed was recorded in Okaloacoochee Slough at Station 11.

Family Lemnaceae

Lemna sp.
Highway 840A Canal, cypress swamp and slough. Floating patches of duckweed were usually associated with nearby rookeries. Found in sheltered areas shaded by cypress, shrub willow and marsh plants.

Order Farinosae (Xyridales)
Family Eriocaulaceae

Eriocaulon sp.
Alligator Alley Canal. Pipewort was sparse along the shallow shoreline of the canal.

Family Pontederiaceae

Pontederia lanceolata Nuttall.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal, Highway 840A Canal, Okaloacoochee Slough, and sawgrass marsh. Pickerel weed was common along the margins of these aquatic habitats.

Family Hetheranthera

Eichornia crassipes Martius
All canal systems except the Interceptor Canal No. 28. Also observed in Okaloacoochee Slough and in the cypress swamp. Floating beds of water hyacinths were most abundant in the Tamiami Trail Canal System. They often blanketed the entire water surface.

Order Liliiflorae (Liliales)
Family Juncaceae

Juncus sp.
GAC Canal System. Rush was common along the shoreline of the canals.

Order Scitamineae
Family Marantaceae

Thalia geniculata Linneaus.
Alligator Alley Canal. Fire flag was common in the shoreline shallows of Station 14.

Order Polygonales
Family Polygonaceae

Polygonum spp.
Tamiami Trail Canal, cypress swamp and Okaloacoochee Slough. Smartweeds were common near the margins of Stations 5, 11 and 28.

Order Ranales
Family Ceratophyllaceae

Ceratophyllum sp.
Tamiami Trail Canal, and Highway 840A Canal. Coontail was common at Stations 29 and abundant at Station 17.

Family Nymphaceae

Nuphar sp.
Tamiami Trail Canal. Spatterdock was collected at Station 5 only. It was common in the canal at this station.

Order Myrtiflorae (Myrtales)
Family Haloragidaceae

Myriophyllum sp.
Highway 840A Canal. Water milfoil was abundant on the channel bottom at Station 17.

Order Umbelliflorae (Umbellales)
Family Umbelliferae

Hydrocotyle umbellata Linneaus.
GAC Canal System, Highway 840A Canal and Okaloacoochee Slough. Sparse patches of waterpenny were recorded at Stations 11, 23 and 27.

Order Contortae (Gentianales)
Family Gentianaceae

Nymphoides aquaticum.

Highway 840A Canal. Near the margin of the canal at Station 17 an occasional floating-heart leaf was observed.

Order Tubiflorae (Polemoniales)
Family Scrophulariaceae

Bacopa caroliniana Walter.

All aquatic habitats except GAC Canal System, Highway 29 Canal, the pond and the Interceptor Canal No. 28. Water hyssop was common to abundant along the margins of canals, sloughs, marshes and prairies.

Family Lentibulariaceae

Utricularia spp.

GAC Canal System, Alligator Alley Canal, Tamiami Canal, wet prairie and sawgrass marsh. Bladderworts were common in the canals and abundant throughout the prairie and marsh.

AN ANNOTATED LIST OF TERRESTRIAL PLANTS OBSERVED IN VARIOUS HABITATS OF THE BIG CYPRESS SWAMP, FLORIDA
MARCH 1970

Kingdom Plant
Division Pteridophyta

Filicinae.
Terrestrial ferns were observed along the margins of the cypress slough, cypress swamp, and a pond in Fakahatchee Strand.

Division Spermatophyta
Subdivision Gymnospermae
Order Coniferae
Family Pinaceae

Pinus elliotti Engelmann.
Slash pines were common along the margins of the GAC Corporation (GAC) Canal System, and the cypress slough.

Taxodium distichum Richardson.
Bald cypress trees were observed in the vicinity of all stations studied.

Order Glumiflorae
Family Gramineae

Andropogon sp.
Beard grass was sparse to common along the GAC Canal System, Alligator Alley Canal, Interceptor Canal No. 28 and near the margin of a cypress slough in Fakahatchee Strand.

Poa pratensis Linnaeus.
Meadow grass was common to the shorelines of the GAC Canal System, Alligator Alley Canal, Highway 840A Canal, Interceptor Canal No. 28, and near the margin of a cypress slough in Fakahatchee Strand.

Order Farinosae
Family Bromeliaceae

Tillandsia usneoides Linnaeus
Spanish moss was observed in the trees (primarily bald cypress) that bordered nearly every habitat studied.

Tillandsia sp.
Air plants were ubiquitous in the Big Cypress area.

Order Liliiflorae
Family Liliaceae

Smilax sp.
Greenbriar were observed along most canals and in higher elevation of the cypress swamp and sloughs.

Order Microspermae

Orchidaceae.
Orchids were observed attached to bald cypress in the shaded areas of the cypress swamp.

Order Salicales
Family Salicaceae

Salix spp.
Willows were generally distributed throughout the Big Cypress area. They were most abundant along the 840A Canal (Station 27). Willows native to the study area were *Salix amphibia* Small, and *Salix caroliniana* Michaux.

Order Myricales
Family Myricaceae

Myrica cerifera Linnaeus.
Southern wax-myrtle was observed along Tamiami Trail Canal, Highway 840A Canal and in the wet prairie study area.

Order Casuarinales
Family Casuarinaceae

Casuarina equisetifolia Forster.
Australian pine have been transplanted in Dade County along the southern shoreline of the Tamiami Trail Canal.

Order Fagales
Family Fagaceae

Quercus virginiana Miller.
Live oak was observed along the GAC Canal System.

Order Urticales
Family Moraceae

Ficus aurea Nuttall.
Strangler fig was observed wrapped around cabbage palms along the banks of the Tamiami Trail.

Ficus sp.
Rubber trees were observed in the cypress slough.

Order Ranales
Family Magnoliaceae

Magnolia grandifolia Linnaeus.
Southern magnolia was observed in the mixed hardwood forest surrounding a pond in Fakahatchee Strand.

Magnolia virginiana Linnaeus.
Southern sweet bay was observed along the shorelines of GAC Canal System and the Tamiami Trail Canal.

Family Lauraceae

Persea palustris (Rafinesque) Sargent.
Swamp bay was observed along the shorelines of the GAC Canal System and Tamiami Trail Canal.

Order Rosales
Family Rosaceae

Chrysobalanus icaco Linnaeus.
Cocoa-plum was observed in the mixed hardwood forest along Tamiami Trail field stations.

Order Sapindales
Family Anacardiaceae

Rhus toxicodendron Linnaeus.
Poison ivy was present at virtually every station visited.

Family Aceraceae

Acer rubrum Linnaeus.
Red maple was observed along the GAC Canal System. Alligator Alley Canal, Highway 840A, cypress slough, pond, and in the wet prairie and cypress swamp.

Order Palmales
Family Palmae

Sabal palmetto (Walter) Todd.

Cabbage palm was observed near the GAC Canal System, Alligator Alley Canal, Tamiami Trail, Highway 840A, and within the cypress slough, cypress swamp, wet prairie, and Okaloacoochee Slough.

Serenoa repens (Bartram) Small.

Saw palmetto was observed near the GAC Canal System, pond, and within the study site in Okaloacoochee Slough.

Order Rhamnales
Family Vitaceae

Parthenocissus quinquefolia (Linnaeus) Planchon.

Virginia creeper was observed on the shoreline of the Tamiami Trail Canal.

Order Oleales
Family Oleaceae

Fraxinus caroliniana Miller.

Pop-ash was observed near Tamiami Trail, the cypress slough and wet prairie in Fakahatchee Strand.

Order Tubiflorae

Convolvulaceae.

Skunk vine was observed within or near all stations studied.

Labiatae.

Mint was present on the shoreline of the pond in Fakahatchee Strand.

Order Rubiales
Family Caprifoliaceae

Sambucus simpsonii Rehder.

Southern elder was observed near the GAC Canal System and within Okaloacoochee Slough.

Order Campanulatae

Compositae.

Aster was observed near Tamiami Trail and along the shoreline of a pond in Fakahatchee Strand.

AN ANNOTATED LIST OF INVERTEBRATES COLLECTED IN VARIOUS HABITATS OF THE BIG CYPRESS SWAMP, FLORIDA
MARCH 1970

Phylum Porifera
Class Demospongea
Order Haplosclerina

Spongillidae.

Tamiami Trail Canal, cypress swamp and slough. Common on submerged logs at Stations 21 and 28 and on spatterdock (*Nuphar*) stems at Station 5.

Phylum Coelenterata

Hydrozoa.

Highway 840A Canal. Attached to submerged twigs and leaves in drift along the canal edge. Also collected from the stems of pickerelweed (*Pontederia lanceolata*) at Station 27.

Phylum Platyhelminthes
Class Turbellaria
Order Tricladida

Planariidae.

All canal systems, Okaloacoochee Slough, and the cypress swamp. Common on underside of debris in shallows. Collected from the root systems of floating water lettuce (*Pistia stratioites*) and hyacinths (*Eichornia crassipes*). Common in submerged vegetation and especially abundant in *Najas* at Station 28.

Phylum Nemathelminthes

Nematoda.

Common to all aquatic habitats in the Big Cypress area. Collected around the root systems of aquatic plants and near the surface (<5 cm deep) of soft organogenic substrate in canals.

Phylum Bryozoa
Class Endoprocta

Urnatella gracilis Leidy.

Okaloacoochee Slough and Interceptor Canal No. 28. Found attached to submerged twigs, logs, aquatic vegetation and rocks at Stations 11 and 16.

Phylum Annelida

Oligochaeta.

Common to abundant in all the aquatic habitats studied in the Big Cypress area. Generally more abundant in organogenic substrate such as occurred at Stations 5, 28 and 33. Also abundant in the root system of cattails (*Typha*) and pickerelweed (*Pondeteria lanceolata*) at Stations 5 and 11.

Order Plesiopora
Family Tubificidae

Branchiura sowerbyi Bedd.

Interceptor Canal No. 28. Collected in the soft organogenic substrate in mid-channel at Station 16.

Class Hirudinea

Rhynchobdellida.

Collected from all major aquatic habitats in the Big Cypress area. Sparse in the GAC Canal System, but common along shallows of other canals, under rocks, logs and debris. Abundant in the root system of smartweed (*Polygonum*) and arrowhead (*Sagittaria*). Common to abundant in *Najas* beds.

Phylum Arthropoda
Class Crustacea

Cladocera.

All canals, and the cypress slough. Greatest abundance along the slough margin of Station 21, in beds of *Bacopa* and *Najas.* Also abundant in root system of *Typha* and in bladderwort (*Utricularia*) at Station 5.

Subclass Ostracoda

Podocopa.

GAC Canal System and cypress slough. Collected from hyacinth roots at Station 1. Common on decaying vegetation and rooted aquatics (especially *Pontederia*) in the cypress slough at Station 21.

Family Cypridae

Chlamydotheca sp.

GAC Canal System, Alligator Alley Canal, and a cypress slough. Collected from a variety of niches including algae, rooted aquatics, exposed limestone and soft organogenic substrate.

Subclass Copepoda

Eucopepoda.

GAC Canal System, Tamiami Trail Canal, Highway 840A Canal, cypress swamp, slough, sawgrass marsh and wet prairie. Abundant in vegetative debris at Stations 27, 28, and 34. Common to abundant in root systems of hyacinths in the canals.

Order Amphipoda

Gammaridae.

Collected from all aquatic habitats except Highway 29 Canal, Interceptor Canal No. 28, and the pond in Fakahatchee Strand. Common to abundant in the submerged vegetation. Profuse in organic detritus and *Najas* at Station 21 and in the root system of smartweed (*Polygonum*) at Station 11.

Family Talitridae

Hyalella azteca (Saussure).

Collected in the same habitats as Gammaridae. This species constituted the majority of Amphipoda collected at each station.

Order Decapoda
Family Palaemonetes

Palaemonetes spp.

Tamiami Trail Canal, Highway 840A Canal, cypress swamp, slough, and a pond in Fakahatchee Strand. Often profuse in submerged vegetation, especially in *Najas*.

Family Astacidae

Cambarinae.

Tamiami Trail Canal and the sawgrass marsh. Crayfish burrows were observed along many of the canals but specimens were collected at only two Stations (5 and 34). These crayfish were collected in the root systems of cattails (*Typha*) pickerelweed (*Pondeteria*) and arrowhead (*Sagittaria*).

Class Arachnoidae

Hydracarina.

Common to abundant in all the aquatic habitats studied in the Big Cypress area. Profuse densities found in the pickerelweed beds (*Pondeteria*) of Station 18 and in the root systems of water hyacinths (*Eichornia crassipes*) at Station 29.

Class Insecta
Order Ephemeroptera
Family Caenidae

Caenis diminuta Walker.
Collected from all aquatic habitats except Highway 29 Canal. Common to abundant as a sprawler on the soft organic bottom of canals, sloughs, and marshes. Often collected clinging to the root systems of aquatic plants. A profuse population was found in Najas and Bacopa roots as well as entangled in Spirogyra at Station 21.

Caenis sp.
These specimens were young instars, probably diminuta. They were collected in association with the mayfly nymphs specifically identified as C. diminuta.

Family Heptageniidae

Stenonema proximum Traver.
Highway 840A Canal. A single specimen was collected from a submerged log at Station 17.

Family Baetidae

Callibaetis floridanus Burks.
All canals except Highway 29, the GAC Canal System and Interceptor Canal No. 28. Also nymphs were common in the wet prairies and sloughs studied. The most abundant population was found in smartweed roots (Polygonum) at Station 28.

Order Odonata
Family Coenagrionidae - damselfly nymphs of following species were common to abundant in rooted aquatics at all habitats except Highway 29 Canal and the pond. Ischnura posita constituted the majority of specimens taken.

Argia apicalis (Say)
Argia translata Hagen
Enallagma traviatum Selys
Enallagma cardenium (Selys)
Enallagma sp.
Ischnura credula (Hagen)
Ischnura posita (Hagen)
Ischnura sp.
Nehallenia sp.

Family Gomphidae

Aphylla _williamsoni_ Gloyd.
GAC Canal System, Alligator Alley Canal, Tamiami Trail Canal, Highway 840A Canal and Interceptor Canal No. 28. Common as a burrower in the sandy-bottom of these canals.

Family Libellulidae - dragonfly nymphs of the following species were common in detritus and root systems of aquatic plants. They were collected at all habitats except Highway 29 Canal. _Perithemis_ _seminole_ constituted the majority of specimens taken.

Didymops _transversa_ Say
Epicordula _regina_ Selys
Erythemis _simplicicollis_ (Say)
Libellula _pulchella_ Drury
Libellula spp.
Perithemis _seminole_ Calvert
Perithemis sp.
Somatochlora sp.
Tetragoneuria _cynosura_ Say

Order Hemiptera

Belostomatidae.
Alligator Alley Canal. Giant water bugs (mostly _Belostoma_) were collected from organic detritus along the shoreline of Station 14.

Corixidae.
GAC Canal System, Alligator Alley Canal, wet prairie, sawgrass marsh and a pond in Fakahatchee Strand. Common in the soft substrate of these major habitats.

Gerridae.
GAC Canal System and wet prairie. Common among the grasses (_Panicum_) of the prairie and profuse in the root system of _Typha_ at Station 18.

Mesoveliidae.
GAC Canal System. Collected from detritus along the shoreline of Station 18.

Naucoridae.

GAC Canal System, cypress swamp and Okaloacoochee Slough. Common in canals on the root system of water hyacinth (*Eichornia crassipes*) and water lettuce (*Pistia stratioites*). Also collected in roots of smartweed (*Polygonum*) at Station 11. The majority of specimens were *Pelocoris* sp.

Order Trichoptera
Family Hydropsychidae

Cheumatopsyche spp.

Highway 840A Canal and cypress slough. Common to abundant in coontail (*Ceratophyllum*) and milfoil (*Myriophyllum*) at Station 17 and profuse in organic detritus in the cypress slough at Station 21.

Family Hydroptilidae

Agraylea spp.

Tamiami Trail Canal, Highway 840A Canal and a cypress slough. This caddisfly larvae was common in the organic substrate at Stations 5, 21, and 27.

Family Leptoceridae

Leptocella sp.

Alligator Alley Canal and 840A Canal. Present in beds of Najas at Stations 14 and 27.

Oecetis inconspicua (Walker).

Interceptor Canal No. 28. Present in detritus near the shoreline of Station 16.

Oecetis spp.

All canals except Highway 29 Canal. Also collected in the Okaloacoochee Slough and in the cypress swamp. These cased caddisfly larvae were common in submerged vegetation especially in *Najas* at Station 28. Some were collected from detritus along the canal shorelines.

Family Psychomyiidae

Polycentropus spp.

GAC Canal System, Tamiami Trail Canal, Highway 840A Canal, Interceptor Canal No. 28, and a cypress slough in Fakahatchee Strand. These non-cased caddisfly larvae were common in the root system of floating hyacinths (*Eichornia crassipes*) at Station 1 and 29. They were common to abundant on stems and roots of emergent aquatics and often collected in debris along the margins of sloughs and canals.

Psychomyiidae.

Highway 840A. Pupae of this caddisfly were collected attached to a submerged log in Station 17.

Order Lepidoptera

Pyralididae.

Tamiami Trail Canal. Aquatic caterpillars were collected from the underside of floating spatterdock leaves (Nuphar) at Station 5.

Order Coleoptera

Curculionidae.

Tamiami Trail Canal, cypress swamp, and the wet prairie. Weevil larvae were collected in the root system of water hyacinth (Eichornia crassipes) at Stations 28 and 29 and in grasses (Panicum) at Station 33. Larvae were also collected from bottom detritus at Station 29.

Dytiscidae.

GAC Canal System, Tamiami Trail Canal, cypress swamp, slough, pond and wet prairie. The predaceous diving beetles were collected on bottom substrate, on rooted aquatic and in the root system of floating plants such as water hyacinth (Eichornia crassipes) and water lettuce Pistia stratioites). The four most abundant genera of these beetles were Colpius, Suphisellus, Hydaticus and Pachydrus.

Elmidae.

GAC Canal System, Tamiami Trail Canal, and a slough in Fakahatchee Strand. Stenelmis larvae and adults were common in detritus and on rooted aquatics at Stations 5, 21, and 23. Elmid adults were abundant in Sagittaria roots at Station 21.

Haliplidae.

Wet prairie. Crawling water beetle adults (mostly Peltodytes) were common on the submerged portion of grasses and vegetation of the prairie at Station 33.

Helodidae.

Okaloacoochee Slough. These beetles (adults) were present on the root systems of floating water lettuce (Pistia straiotites) at Station 11.

Hydrophilidae.

Tamiami Trail Canal, Okaloacoochee Slough and Interceptor Canal No. 28. The most common water scavenger beetle collected was Enochrus. These beetles were present on root systems of floating water lettuce (Pistia stratioites) and hyacinth (Eichornia crassipes) as well as the root systems of Sagittaria.

Order Diptera
Family Culicidae

Anopheles sp.

Alligator Alley Canal. A single mosquito larva was collected from detritus near the shoreline of Station 14.

Chaoborus sp.

GAC Canal System, Highway 840A Canal, Interceptor Canal No. 28, pond, and wet prairie. Phantom midge larvae were collected from the soft organic substrate at Stations 4, 16, 18, 27, 32 and 33.

Family Chironomidae - Midge larvae were ubiquitous in the Big Cypress Swamp area. Generally, the red larvae of the genus *Chironomus* were found in soft, organogenic substrate. Non-red larvae of the subfamilies Tanypodinae, Orthocladinae and Chironominae, were associated with hard, minerogenic substrate and/or various types of aquatic vegetation. Following is a list of species, and the stations from which each was collected.

Family Chironomidae
Subfamily Tanypodinae

	Stations
Ablabesmyia janta (Roback)	1,18,21,28
Ablabesmyia ornata Beck & Beck	1,5,17,21,23,27,28,29,34
Ablabesmyia sp.	23
Procladius culiciformis (Linnaeus)	5,14,17,28,29,33,34
Coelotanypus concinnus (Coquillett)	1,5,16,18,23,29
Coelotanypus sp.	29
Clinotanypus spp.	5,27,28,33
Larsia lurida Beck & Beck	21,28
Labrundinia floridana Beck & Beck	17
Labrundinia sp.	21
Tanypus stellatus Coquillett	4,5,14,18,32,33

Subfamily Orthocladinae

Nanocladius alternantherae Dendy & Sublette	4,17,21
Cricotopus bicinctus (Meigen)	1,4,17
Cricotopus trifasciatus (Panzer)	16
Brillia par (Coquillett)	5

Subfamily Chironominae
Tribe Chironomini

	Stations
Polypedilum (Polypedilum) *halterale* (Coquillett)	1,4,5,11,14,16,17,18,21, 27,28,33,34
Polypedilum (Polypedilum) *illinoense* (Malloch)	4,5,11,14,21,28,29
Chironomini I Beck	4,5,17,21
Chironomini L Beck	14,16,27,28
Chironomini sp.	5
Chironomus (Chironomus) *attenuatus* Walker	4,5,11,14,16,17,18,27,28, 29,32,33,34
Chironomus (Chironomus) *fulvipilus* Rempel	4,32
Chironomus (Chironomus) *stigmaterus* Say	5,32
Chironomus (Chironomus) *tuxis* Curran	11
Chironomus (Chironomus) *paganus* Meigen	32
Chironomus (Chironomus) sp *B* Beck	29,32,33
Chironomus (Chironomus) sp *C* Beck	11,18,32,33
Chironomus (Chironomus) sp *D* Beck	16
Chironomus (Kiefferulus) *dux* Johannsen	11
Chironomus (Dicrotendipes) *modestus* Say	1,4,5,14,16,17,18,21,27,28, 29,32,33,34
Chironomus (Dicrotendipes) *nervosus* Staeger	17,28,29
Chironomus (Endochironomus) *nigricans* Johannsen	5,14,16,34
Chironomus (Cryptochironomus) *fulvus* Johannsen	4,5,11,14,16,17,18,23
Chironomus (Cryptochironomus) *argus* (Roback)	5
Chironomus spp.	16,32
Parachironomus *carinatus* (Townes)	1,27,28,34
Parachironomus *hirtalatus* (Beck & Beck)	4,18,28,34
Parachironomus *tenuicaudatus* Mallock	1
Harnischia *edwardsi* (Kruseman)	5,27,34
Harnischia *galeator* Townes	14
Harnischia *viridulus* Linnaeus	14
Harnischia sp.	14
Cryptotendipes sp.	5,18
Pseudochironomus sp.	4,29
Pedionomus *beckae* sublette	1,28
Glyptotendipes (Glyptotendipes) *senilis* Joh	16,34
Glyptotendipes sp.	34

Tribe Tanytarsini

Tanytarsus sp *A* Beck	4,14,16,17,21,27,28,29
Tanytarsus sp *B* Beck	4,5,14,17,18,23,27,29,33
Tanytarsus (Rheotanytarsus) *exiguus* Johannsen	4,17,27,29
Tanytarsus sp *5* Roback	1,4,5,14,17,18,21,27,28, 29,32,33
Tanytarsus *querlus* (Roback)	27
Tanytarsus sp.	1,29
Atanytarsus sp *C* Beck	4,5,11,14,17,18,21,27, 33,34
Atanytarsus sp *A* Beck	34

Ceratopogonidae.

Generally distributed at all aquatic habitats in the Big Cypress area. Biting midge larvae were associated with numerous niches at each station, including rooted aquatics, floating aquatics, detritus and algal masses.

Tabanidae.

Pond and wet prairie in Fakahatchee Strand. Horsefly larvae were common in the substrate at Stations 32 and 33.

Tipulidae.

GAC Canal System. Cranefly larvae were common on the organic substrate at Station 4.

Phylum Mollusca
Class Gastropoda
Order Ctenobranchiata
Family Ampullariidae

Pomacea spp.

Tamiami Trail Canal and sawgrass marsh. Shells of the apple snail were collected at virtually every station sampled. Eggs were recorded at numerous stations also, but live adults were collected at Stations 5 and 34 only.

Family Pleuroceridae

Goniobasis spp.

Tamiami Trail Canal. Common to abundant on cattails (Typha), pickerelweed (Pontederia) and on hard substrate at Station 5.

Pleurocerinae.

Interceptor Canal No. 28. These snails were common to abundant in detritus near the shoreline and on Sagittaria at Station 16.

Order Pulmonata

Ancylidae.

Generally distributed in the aquatic habitats of the Big Cypress Swamp area. Most common on emergent vegetation, primarily on Typha.

Ferrissia spp.

All aquatic habitats except the Alligator Alley Canal. Limpets were common on submerged stems of rooted aquatics. Occasionally they were collected from submerged detritus or debris.

Physidae.

Generally distributed in the aquatic habitats of the Big Cypress Swamp area. Specimens were collected from numerous niches including floating and rooted vegetation, detritus, and occasionally on exposed limestone at the water's edge. The most common pouch snail was *Physa* spp.

Planorbidae.

GAC Canal System, Tamiami Trail Canal, 840A Canal, wet prairie and sawgrass marsh. Orb snails were common in submerged vegetation and on detritus at Stations 1, 17, 18, 29, 33 and 34. *Helisoma* was the most common genera.

Class Pelecypoda

Sphaeriidae.

GAC Canal System, Alligator Alley Canal, Tamiami Canal, 840A Canal, Interceptor Canal No. 28, slough, and cypress swamp. Common to abundant in root systems of emergent aquatic plants. Also collected from bottom detritus.

Unionidae.

Tamiami Trail Canal. These clams were collected near the rooted base of *Typha* at Station 5.

AN ANNOTATED LIST OF FISH OBSERVED IN VARIOUS HABITATS OF THE BIG CYPRESS SWAMP, FLORIDA
MARCH 1970

Phylum Pisces
Class Teleostomi
Order Ammiiformes
Family Ammiidae

Amia calva Linnaeus.

Bowfins were observed at Station 21 only.

Order Lepisosteiformes
Family Lepisosteidae

Lepisosteus platyrhincus DeKay.

The Florida spotted gar was observed in large numbers at Stations 11, 14, 17, 27, 28, 29 and 32.

Order Cypriniformes
Family Cyprinidae

Notemigonus crysoleucas (Mitchell).

The golden shiner ranged from sparse to abundant throughout the area and was observed at Stations 14, 21, 28, and 33.

Family Ictaluridae

Ictalurus nebulosus (LeSuer).

Although the brown bullhead was probably present at all stations due to its furtive habits, it was observed at Stations 5 and 14 only.

Order Cyprinodontiformes
Family Cyprinodontidae

Lucania goodei Jordon.

The red-finned killifish was observed swimming among the vegetation and along the edges of all stations except 14, 23 and 27.

Family Poeciliidae

Gambusia sp.

The mangrove mosquito fish was seen working the surface of all stations except 17 and 34.

Heterandria formosa Agassiz.

The least killifish, although seen in large numbers at other stations, was not observed at Stations 16, 17, 23 and 29.

Mollienesia latipinna LaSueur.

The sailfin molly was observed at Stations 4 and 23.

Order Mugiliformes
Family Mugilidae

Mugil cephalus Linnaeus.

Striped mullet were observed at Station 27 only.

Order Perciformes
Family Centrarchidae

Centrarchus macropterus (Lacepede).

Fliers were observed in Stations 21 and 29 both of which were clear relatively fast flowing streams associated with cypress swamps.

Chaenobryttus coronarius (Bartram).

Sloughs or ponds associated with cypress swamps appeared to be preferred by the warmouths since they were observed in Stations 21, 29 and 32 only.

Lepomis macrochirus Rafinesque.

Bluegills were observed in all stations but 1 and 4.

Lepomis microlophus (Gunther).

The redear sunfish was observed at Station 17.

Micropterus salmoides floridanus (LeSueur).

The Florida largemouth bass was observed at all stations but 1, 4, 23 and 33.

AN ANNOTATED LIST OF BIRDS OBSERVED AT VARIOUS STATIONS IN THE BIG CYPRESS SWAMP

Phylum Aves
Order Podicipitiformes
Family Podicipitidae

Podilymbus podiceps (Linnaeus).
Pied billed grebes were present at Station 11 and 17, both of which were associated with open wet prairie.

Order Pelicaniformes
Family Phalacrocoracidae

Phalacorocorax auritus (Lesson).
The double-crested cormorant was observed actively engaged in fishing or resting in a cabbage palm at Station 11.

Family Anhingadae

Anhinga anhinga (Linnaeus).
The water turkey was seen at Stations 5,11,14 and 28 and was usually perched on a tree resting or drying its wings.

Order Ciconiiformes
Family Ardeidae

Ardea herodias Linnaeus.
The great blue heron was seen at Stations 11,17,18 and 21, either feeding in the shallow water or perched in a high tree overlooking the station.

Butorides virescens (Linnaeus).
The green heron was observed at Stations 11, 17 and 28, usually perched on a low overhanging branch searching for food organisms in the water.

Florida caerulea (Linnaeus).
Little blue herons were seen feeding in the shallows or perched in nearby trees at Stations 5,11,21,29,32 and 34.

Florida thula (Molina).
Snowy egrets were present at Stations 5,11,16,21,27,29 and 34.

Casmerodius albus (Linnaeus).
The American egret was present at all stations but 1,4,16,23,27 and 34.

Family Ciconiidae

Mycteria americana Linnaeus.

Wood storks were seen feeding in the shallow weed infested waters of Station 11 and were observed perched in cypress trees near Stations 21 and 28.

Family Theskiornithidae

Ajaia ajaja (Linnaeus).

A single roseate spoonbill was seen feeding in a canal near Station 18.

Eudocimus albus (Linnaeus).

The white ibis was seen at Stations 11 and 33, both of which are located in open wet prairie habitat.

Order Anseriformes

Family Anatidae

Anus discors Linnaeus.

A flock of blue-winged teal were seen flying over the flooded prairie of Station 11.

Anus fulvigula Ridgway.

Mottled ducks were associated with the wet prairie around Station 11.

A single muscovy duck flew into the canal at Station 1 which is associated with a residential area.

Order Falconiformes

Family Cathartidae

Cathartes aura (Linnaeus).

Although turkey vultures were only observed resting in trees or flying over five of the sixteen stations, they were present throughout the swamp.

Coragyps atratus (Bechstein).

The black vulture was not nearly as common as the turkey vulture and was observed at only Stations 11, 14 and 23.

Family Accipitridae

Elanoides furficatus (Linnaeus).

The swallow-tailed kite was soaring high in the sky over the open pond and wet prairie, Stations 32 and 33.

Buteo lineatus (Gmelin).

Red-shouldered hawk were common throughout the great cypress swamp. They were seen in all types of habitat and were present at eight of the sixteen stations.

Order Gruiformes

Family Gruidae

Grus canademsis (Linnaeus).

The sandhill crane was present at Station 11 which is located in an agricultural area which was formerly wet prairie.

Family Aramidae

Aramus guarauna (Linnaeus).

Limpkins were associated with areas consisting of shallow water and tall grasses such as Stations 5,11,33 and 34.

Family Rallidae

Fulica americana Gmelin.

The American coot was very abundant in the canals along the Tamiami Trail but were present in only three of the sixteen biological stations (5, 17, 29).

Porzana jamaicensis (Gmelin).

The Florida gallinule was not observed in any of the stations; however, it was common enough throughout the area to warrant its mention.

Order Strigiformes

Family Strigidae.

This owl was not identified but was present at Station 32.

Order Coraciiformes

Family Alcedinidae

Megaceryle alcyon (Linnaeus).

The belted kingfisher was commonly seen sitting on lines and trees overlooking fishing areas throughout the swamp and was observed at Stations 17, 21 and 33.

Order Piciformes

Family Picidae

Colaptes auratus (Linnaeus).

The yellow-shafted flicker was associated with drier hardwood hammocks and seen from Stations 4, 18 and 27.

Dryocopus pileatus (Linnaeus).
Pileated woodpeckers were quite common throughout the swamp and could usually be heard calling from the deep swamp or seen in their characteristic flight from one patch of forest to the other. They were listed in Stations 14, 21, 23, 32 and 33.

Sphyrapicus (varius) varius (Linnaeus).
The yellow bellied sapsucker finds the imported Australian pine (Casuarina equisetifolia) an excellent food item and as a result were present at Station 5, which is the only station where this tree is present.

Order Passeriformes
Family Tyrannidae

Myiarchus crinitus (Linnaeus).
The crested flycatcher was seldom seen but could be heard calling from the willow and myrtle understory in the woods surrounding Stations 23, 32 and 33.

Family Hirondinidae

Tachycineta bicolor (Vieillot).
At times great masses of tree swallows could be seen feeding over the swamps and marshes. They were present in smaller numbers at Stations 11, 16 and 17.

Progne subis (Linnaeus).
Purple martins were seen feeding high above Station 1 which is located near a residential area.

Family Corvidae

Corvus brachyrhynchus Brehm.
The common crow was present at Stations 4,5,14,16,21,23 and 27, but could commonly be seen feeding along the road or winging its way across the swamp.

Cyanocitta cristata (Linnaeus).
The bluejay was seen only at Station 32.

Family Paridae

Baeolophus bicolor (Linnaeus).
The tufted titmouse was associated with the mature timber surrounding Stations 1,17,28 and 33.

Family Troglodytidae

Thryothorus ludovicianus (Latham).
The Carolina wren was seen and heardsinging in the understory of the woods surrounding Stations 14,17,27,32 and 33.

Family Mimidae

Dumetella carolinensis (Linnaeus).
The catbird was seen fretting and scolding in the willow thickets by Stations 5,29 and 33.

Mimus polyglottos (Linnaeus).
A mocking bird was heard singing from the top of a dwarf cypress at Station 16.

Taxostoma rufum (Linnaeus).
Although brown thrashers were seen occasionally in the willow thickets along the roads only one was directly associated with any station. This was seen in the understory surrounding the pond at Station 32.

Family Vireonidae

Vireo grisens (Boddaert).
The white-eyed vireo could be heard calling from deep in the swamp at Stations 14,27 and 32.

Vireo olivaceus (Linnaeus).
A red-eyed vireo was associated with mature forest adjacent to Station 17.

Family Parulidae

Dendroica palmarum (Gmelin).
Palm warblers were seen feeding in the small trees along the road in the altered wet prairie area at Station 11.

Geothlypis trichas (Linnaeus).
Yellow throats were associated with the leafy branches of trees at Stations 5,11, and 27.

Limnothlypis swainsonii (Audubon).
Swainsons warblers were seen in the thickets along the road at Station 11.

Family Icteridae

Agelaius phoeniceus (Linnaeus).
Red-winged blackbirds were very common throughout the area and could usually be seen hanging over the water from cattails or willow branches or flying in flocks over the swamp. They were present at Stations 4,5,11,14, and 34.

Cassioix mexicanus (Gmelin).
Boattailed grackles were nesting in the Australian pines at Station 5.

Quiscalus quiscula (Linnaeus).
Purple grackles appeared to be attracted to the canals along the open roadways of Alligator Alley and Tamiami Trail and were listed at Stations 5,14,28,29, and 32.

Sturnella magna (Linnaeus).
Meadow larks were seen in the pasture land around Station 11.

Family Fringillidae

Melospiza georgiana (Latham).
The swamp sparrow was observed actively feeding on insects associated with beds of water lettuce at Station 11.

Melospiza melodia (Wilson).
The song sparrow was observed along the roadside at Station 11 only.

Pyrrhuloxia cardinalis (Linnaeus).
Cardinals were associated with large timber surrounding such areas as Stations 17,28,32 and 33.

TABLE C-IV

DISTRIBUTION AND ABUNDANCE OF CERTAIN AQUATIC PLANTS IN THE BIG CYPRESS SWAMP, FLORIDA
MARCH 1970

PLANT	STATION	WATER DEPTH (METERS)	SUBSTRATE	DENSITY/M^2 PLANTS	DENSITY/M^2 LEAVES	REMARKS
Azolla caroliniana	14	Floating	--	Not analyzed by quadrat		Sparse patches in quiet areas near the shoreline
Typha augustifolia	1	0.1	Sand and detritus	12	78	Common along both shores
	4	0.1	Sand and detritus	3	20	Covers less than 1% of shoreline
	5	0.2	Sand and detritus	15	91	Common along north shoreline
	14	1.8	Sand and detritus	4	25	Covers about 5% of shoreline
	17	0.5	Sand and detritus	10	64	Common along eastern shoreline
	18	0.0-1.0	Sand and detritus	6	43	Covers about 20% of shore
	23	0.1-1.0	Sand and detritus	13	81	Covers about 10% of shore
Typha latifolia	11	0.5	Sand and detritus	6	40	Covers 15% of shoreline
Potamogeton sp.	27	1.3	Sand and detritus	6	30	Sparse along both shorelines
Najas sp.	1	0.1-1.0	Sand, detritus, & shell	Not analyzed by quadrat		Covers about 10% of bottom
	4	0.5	Detritus			Covers about 70% of bottom
	14	0.1-1.6	Sand and detritus			Covers about 20% of bottom
	16	0.1-1.0	Detritus over rock			Covers about 10% of bottom
	17	0.2-1.0	Detritus over rock			Covers about 60% of bottom
	18	0.1-1.5	Sand and detritus			Covers about 15% of bottom
	21	0.8	Sand and detritus			Covers about 65% of bottom
	23	0.1-1.5	Sand and detritus			Covers about 20% of bottom

AQUATIC PLANTS, BIG CYPRESS SWAMP (Cont'd)

PLANT	STATION	WATER DEPTH (METERS)	SUBSTRATE	DENSITY/M^2		REMARKS
				PLANTS	LEAVES	
	27	1.8	Sand and detritus	Not analyzed by quadrat		Covers about 85% of bottom
	28	0.9-1.8	Detritus			Covers about 50% of bottom
	29	0.1-2.5	Detritus			Covers over 80% of bottom
	32	0.1-1.0	Detritus over rock			Covers about 30% of shoreline
Sagittaria graminea	14	0.7-1.8	Sand and detritus	8	42	Scattered along shoreline
	16	0.1-0.8	Detritus over rock	10	68	Scattered along shoreline
	23	0.2	Sand and detritus	18	130	Covers about 1% of shoreline
	27	0.5	Sand and detritus	6	38	Scattered along shoreline
Sagittaria sp.	5	0.4	Detritus over rock	26	185	Covers 5% of shoreline
	11	1.0	Sand	25	188	Covers 40% of shoreline
	16	0.5	Detritus over rock	5	31	Scattered along shoreline
	17	0.6	Detritus over rock	8	53	Covers 10% of shoreline
	21	0.8	Sand and detritus	1	8	Scattered along shoreline
	28	0.9	Peat	6	31	Covers about 1% of area
	32	0.4	Detritus over rock	7	52	Covers about 1% of area
	33	0.2	Peaty muck	2	13	Covers about 5% of area
	34	0.5	Peaty muck	7	46	Covers about 5% of area
Anacharis sp.	14	1.6	Sand and detritus	1	6	Sparse along shoreline
Leersia hexandra	21	1.0	Sand and detritus	-	28	Sparse along shoreline
Panicum hemitomum	1	0.2-1.5	Sand and detritus	-	33	Sparse along shoreline
	5	0.1	Detritus over rock	-	81	Sparse along shoreline
	11	1.2	Sand	-	54	Sparse along shoreline
	33	0.1	Peat and muck	-	366	Covers over 90% of area
	34	0.5	Peat and muck	-	35	Sparse along shoreline

AQUATIC PLANTS, BIG CYPRESS SWAMP (Cont'd)

PLANT	STATION	WATER DEPTH (METERS)	SUBSTRATE	DENSITY/M^2 PLANTS	DENSITY/M^2 LEAVES	REMARKS
Cladium jamacensis	5	0.3	Detritus over rock	-	283	Covers about 1% of shoreline
	29	0.2	Detritus over rock	-	32	Sparse along shoreline
	32	0.2	Detritus over rock	-	52	Sparse along shoreline
	34	0.5	Peat and muck	-	163	Covers over 90% of shoreline
Pistia stratiotes	11	Floating	--	93	-	Covers 50% of water surface
	17	Floating	--	8	-	Scattered plants floating in area
	23	Floating	--	27	-	Scattered plants along both shorelines
Lemna sp.	17	Floating	--	30	-	Scattered patches in area
	21	Floating	--	over 200	-	Scattered patches in area
	28	Floating	--	over 200	-	Scattered patches in area
Eriocaulon sp.	14	0.1	Detritus	6	-	Sparse along shoreline
Eichornia crassipes	1	Floating	--	26	-	Scattered floating plants
	11	Floating	--	40	-	Scattered floating plants
	17	Floating	--	6	-	Scattered floating plants
	28	Floating	--	13	-	Scattered floating plants
	29	Floating	--	86	-	Covers 30% of water surface
Pontederia lanceolata	5	0.4	Silt over rock	22	195	Covers about 5% of shoreline
	11	1.0	Sand	8	54	Sparse along shoreline
	14	1.0	Sand and detritus	10	64	Sparse along shoreline
	18	0.3	Sand and detritus	2	13	Sparse along shoreline
	21	0.6-1.0	Sand and detritus	7	45	Sparse along margin
	23	0.2	Sand and detritus	11	81	Sparse along shoreline
	27	0.9	Sand and detritus	11	80	Sparse along shoreline
	34	0.5	Peat and muck	15	143	Covers about 5% of shoreline

AQUATIC PLANTS, BIG CYPRESS SWAMP (Cont'd)

PLANT	STATION	WATER DEPTH (METERS)	SUBSTRATE	DENSITY/M^2 PLANTS	DENSITY/M^2 LEAVES	REMARKS
Juncus sp.	18	0.1-0.5	Sand and detritus	-	53	Covers about 10% of shoreline
Thalia geniculta	14	0.6	Detritus and sand	2	22	Covers about 5% of shoreline
Polygonum spp.	5	0.5	Detritus over rock	3	-	Covers about 1% of shoreline
	11	1.2	Sand	10	-	Covers about 5% of shoreline
	28	1.0	Detritus	6	-	Covers about 1% of area
Ceratophyllum sp.	17	0.2-1.0	Detritus over rock	Not analyzed by quadrat		Covers 40% of bottom
	29	0.1-1.5	Detritus over rock			Covers 10% of bottom
Nuphar sp.	5	0.1-2.6	Detritus over rock	-	31	Floating leaves cover less than 1% of canal surface
Myriophyllum sp.	17	0.2-1.0	Detritus over rock	Not analyzed by quadrat		Covers 25% of bottom
Hydrocotyle umbellata	11	1.2	Sand	-	6	Scattered floating leaves
	23	0.3	Detritus	-	48	Floating leaves cover less than 1% of area
	27	0.2	Detritus and sand	-	4	Scattered floating leaves
Nymphoides aquaticum	17	0.2	Detritus over rock	-	5	Scattered floating leaves
Bacopa caroliniana	5	0.1-1.2	Detritus over rock	Not analyzed by quadrat		Covers about 10% of bottom
	14	0.3	Rock, shell and sand			Covers about 10% of bottom
	17	0.2-1.0	Detritus over rock			Covers about 20% of bottom
	21	0.6-1.0	Sand over rock			Covers about 15% of bottom
	27	1.0	Sand and detritus			Covers about 5% of bottom
	28	1.0-1.8	Detritus and muck			Covers about 5% of bottom
	33	0.2	Peat and muck			Densely intermingled among grasses
	34	0.5	Peat and muck			Densely intermingled among sedges

AQUATIC PLANTS, BIG CYPRESS SWAMP (Cont'd)

PLANT	STATION	WATER DEPTH (METERS)	SUBSTRATE	DENSITY/M^2		REMARKS
				PLANTS	LEAVES	
Utricularia spp.	4	0.2	Detritus			Covers about 1% of bottom
	5	0.1-0.4	Detritus over rock	Not analyzed		Covers about 5% of bottom
	14	1.0	Sand and detritus	by quadrat		Covers about 5% of bottom
	18	0.1-1.5	Sand and detritus			Covers about 1% of bottom
	23	0.1-1.5	Detritus and sand			Covers about 1% of bottom
	33	0.2	Peat and muck			Covers about 5% of bottom
	34	0.5	Peat and muck			Covers about 5% of bottom

DISTRIBUTION AND ABUNDANCE OF BENTHOS IN THE BIG CYPRESS SWAMP, FLORIDA*
MARCH 1970

ORGANISM	STATION															
	1	4	5	11	14	16	17	18	21	23	27	28	29	32	33	34
Planariidae			4				8	10								
Urnatella gracilis				**		**										
Oligochaeta	43	181	211	15	23	144	76	15	53	20	114	265	189	70	370	
Branchiura sowerbyi						7										
Hirudinea			34				83	3			38	247	106			8
Cladocera		3	4						174							
Ostracoda	13							33	53							
Copepoda															8	
Amphipoda	3	8	27		8		61	8	1886	15	8		672		8	68
Palaemonetes spp.														236		
Hydracarina	3	5	30			3	23	10	295	3	53	181	60	6	15	
Caenis diminuta	20	18	246			129		28	2462	149		83	211		8	15
Caenis sp.									144							
Callibaetis floridanus			4													
Argia translata								5								
Enallagma traviatum						5										
Enallagma sp.												30				
Ischnura posita			7				15	8	136		53					
Ischnura sp.						3						45				
Nehallenia sp.								3								
Anisoptera (young instar)								8								
Aphylla williamsoni	1		7		4	3	8				15					
Libellulidae											78					
Didymops transversa							8									
Epicordula regina						3										
Libellula pulchella		3						3								
Libellula sp.									15							
Perithemis seminole						5	15	20		23		30				
Somatochlora sp.			5													
Tetragoneuria cynosurus	1						8									
Corixidae	3					3		3							8	
Mesoveliidae								3								

** Colonies not evaluated quantitatively.

DISTRIBUTION AND ABUNDANCE OF BENTHOS, BIG CYPRESS SWAMP (Cont'd)

ORGANISM	STATION 1	4	5	11	14	16	17	18	21	23	27	28	29	32	33	34
Trichoptera pupa								7								
Cheumatopsyche sp.							234									
Hydroptilidae								83								
Agraylea sp.			7						68		8					
Leptoceridae			3					5								
Leptocellus sp.											15					
Oecetis inconspicua						19										
Oecetis spp.	3		7	8		3	38		53	3	53					
Polycentropus sp.						45	7	3	68	25	15					
Lepidoptera		3														
Curculionidae													8			
Stenelmis sp.									15							
Diptera larvae		3														
Chaoborus sp.		23				3		10			8			24	30	
Ablabesmyia janta								3	8							
Ablabesmyia ornata			4						8	13	8	8				
Ablabesmyia sp.										5						
Procladius culiciformis			200		4		53					99	23			15
Procladius sp.		10						53	23	25	159					
Coelotanypus concinnus	8		4			3		38		40			8			
Clinotanypus spp.			38								242	53			30	
Larsia lurida									8							
Labrundinia sp.									8							
Tanypus stellata		13	4		61			3						51	15	
Cricotopus bicinctus	1	15														
Polypedilum (P.) halterale	5	3	4	4		547		103	8		898	23			8	
P. illinoense		3	250										30			
Chironomini sp. L. Beck		3	4						8							
Chironomini sp. L. Beck					87	66					23					
Chironomus (Chironomus) attenuatus		40	60		627	64	770	98			60	182	2839	6	884	8
C. (C.) fulvipilus		23														
C. (C.) stigmaterus														24		
C. (C.) paganus														12		

DISTRIBUTION AND ABUNDANCE OF BENTHOS, BIG CYPRESS SWAMP (Cont'd)

ORGANISM	STATION 1	4	5	11	14	16	17	18	21	23	27	28	29	32	33	34
Chironomus (Chironomus) sp. b. Beck													60	9		
C. (C.) sp. C. Beck								3						6	106	
C. (Kiefferulus) dux				129												
C. (Dicrotendipes) modestus		15	23			5		10	76		8	295	53			15
C. (D.) nervosus													8			
C. (Endochironomus) fulvus		10	30	8	53	15	8	8		5						
C. (Cryptochironomus) sp.			4			7				3						
Parachironomus carinatus											8					
P. hirtalatus		5						3								
Harnischia edwardsi			19													8
H. galeator					4											
H. viridulus					8											
Harnischia sp.					8											
Cryptotendipes sp.			4					13								
Pseudochironomus sp.		3														
Pedionomus beckae	3															
Tanytarsus sp. A. Beck		13							114		8	8				
T. sp. B. Beck		4	242				28	250		18	906		53		15	
T. (Rheotanytarsus) exiguus		125					76				8		8			
T. sp. 5 Roback		28	4		113		38	60	38		1118	30	340		76	
T. cuerlus											23					
Atanytarsus sp. C. Beck		20	185	46			91	23	38		891				23	
Ceratopogonidae	10	66	5		46	74	127	229	423	116	363	181			174	
Tabanidae														8	8	
Tipulidae		3														
Pomacea caliginosa			84													
Pleuroceridae						30										
Goniobasis sp.			514													
Ferrissia sp.	1						23	5				30	23	3		23
Physidae								5						9		
Physa sp.	15				15		61	10		3			23	15		
Helisoma sp.	13						15						45		8	
Sphaeriidae	25		72	91		20	182		53							
Unionidae			7													

* Samples were collected with a Petersen dredge and recorded as the average number of organisms per square meter.

PART 3

BACTERIAL

FIGURE C-1
DAILY TOTAL COLIFORM CONCENTRATIONS AT G.A.C. CANAL STATIONS

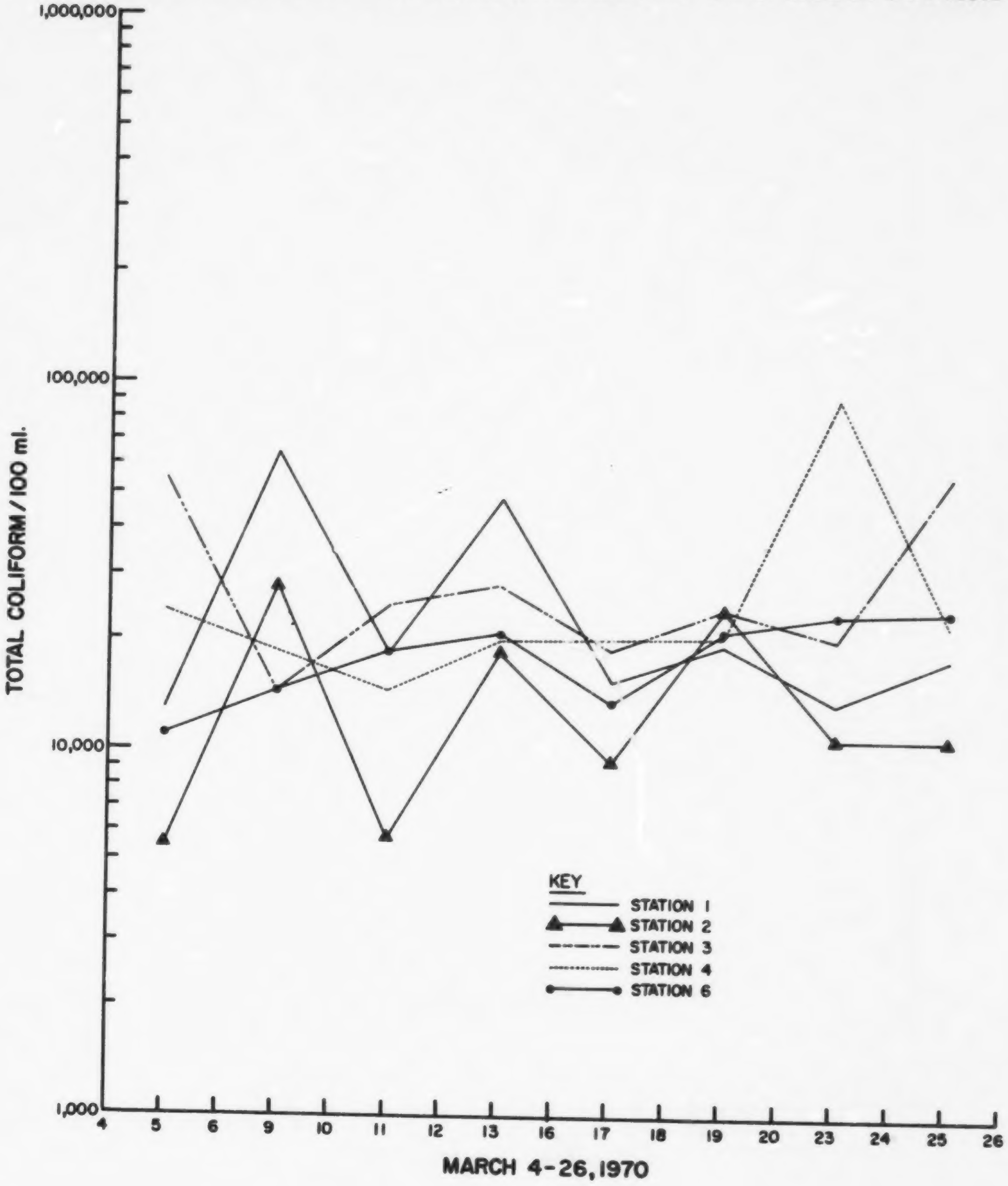


FIGURE C-2
DAILY TOTAL COLIFORM CONCENTRATIONS AT G.A.C. CANAL STATIONS

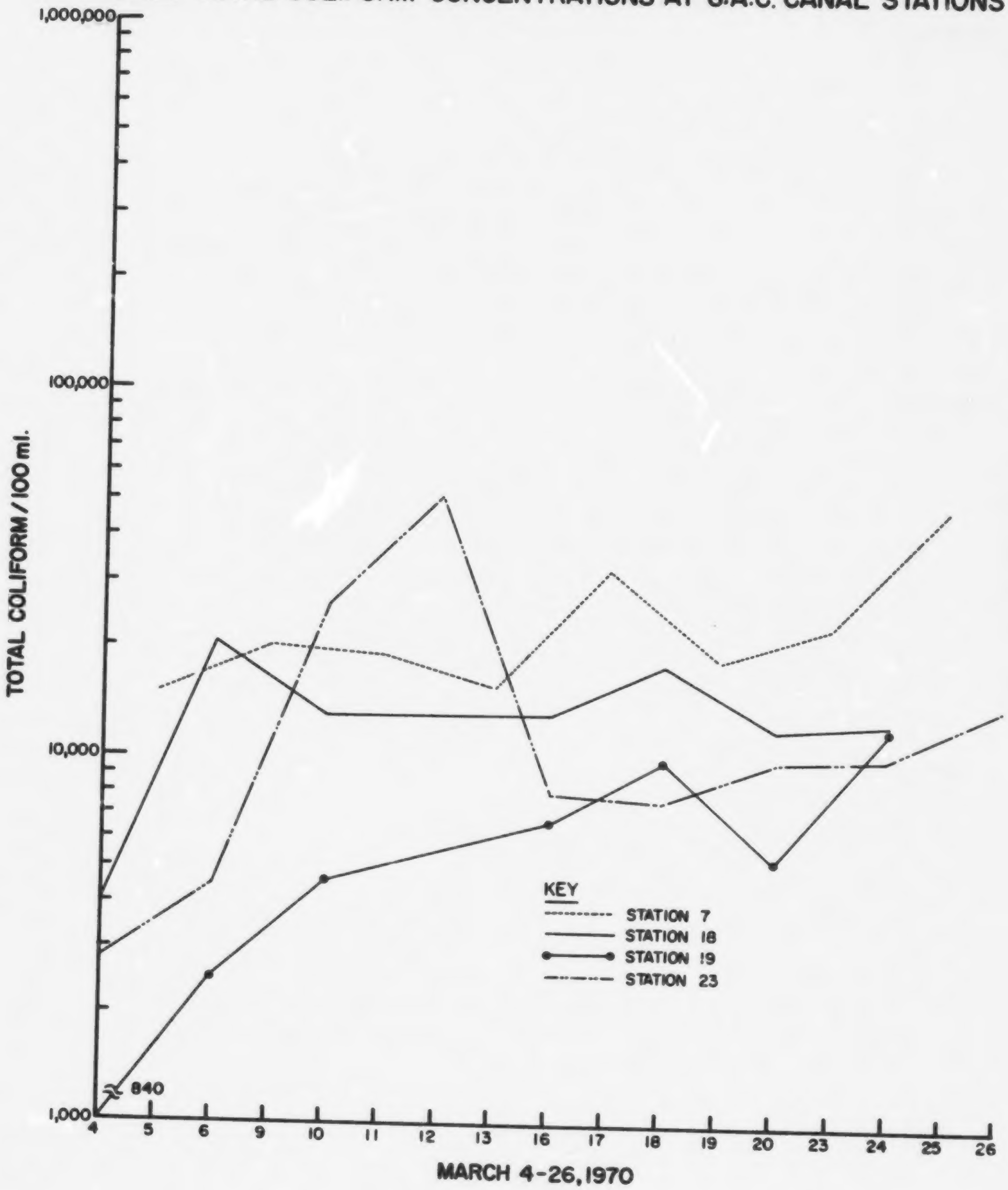
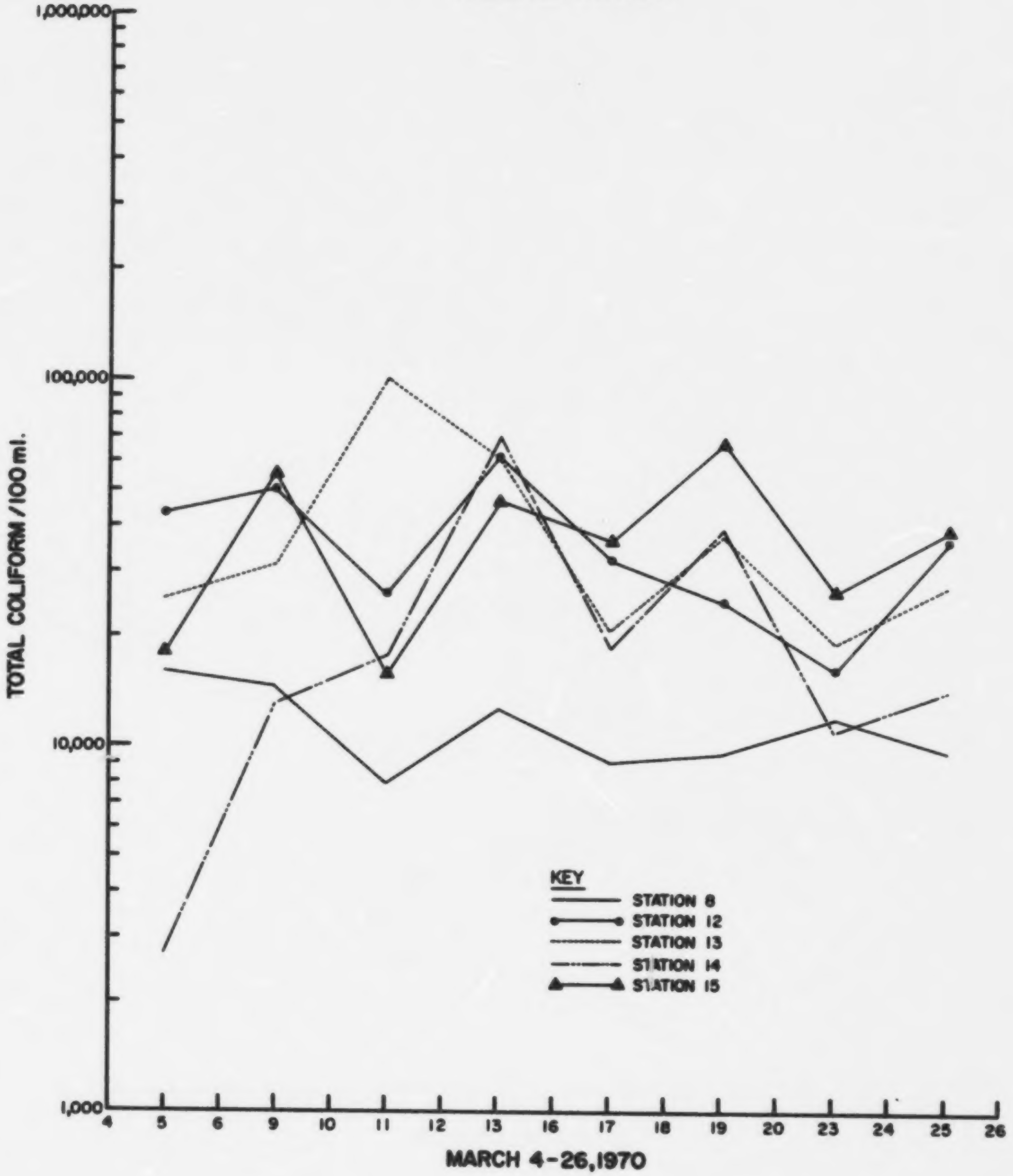
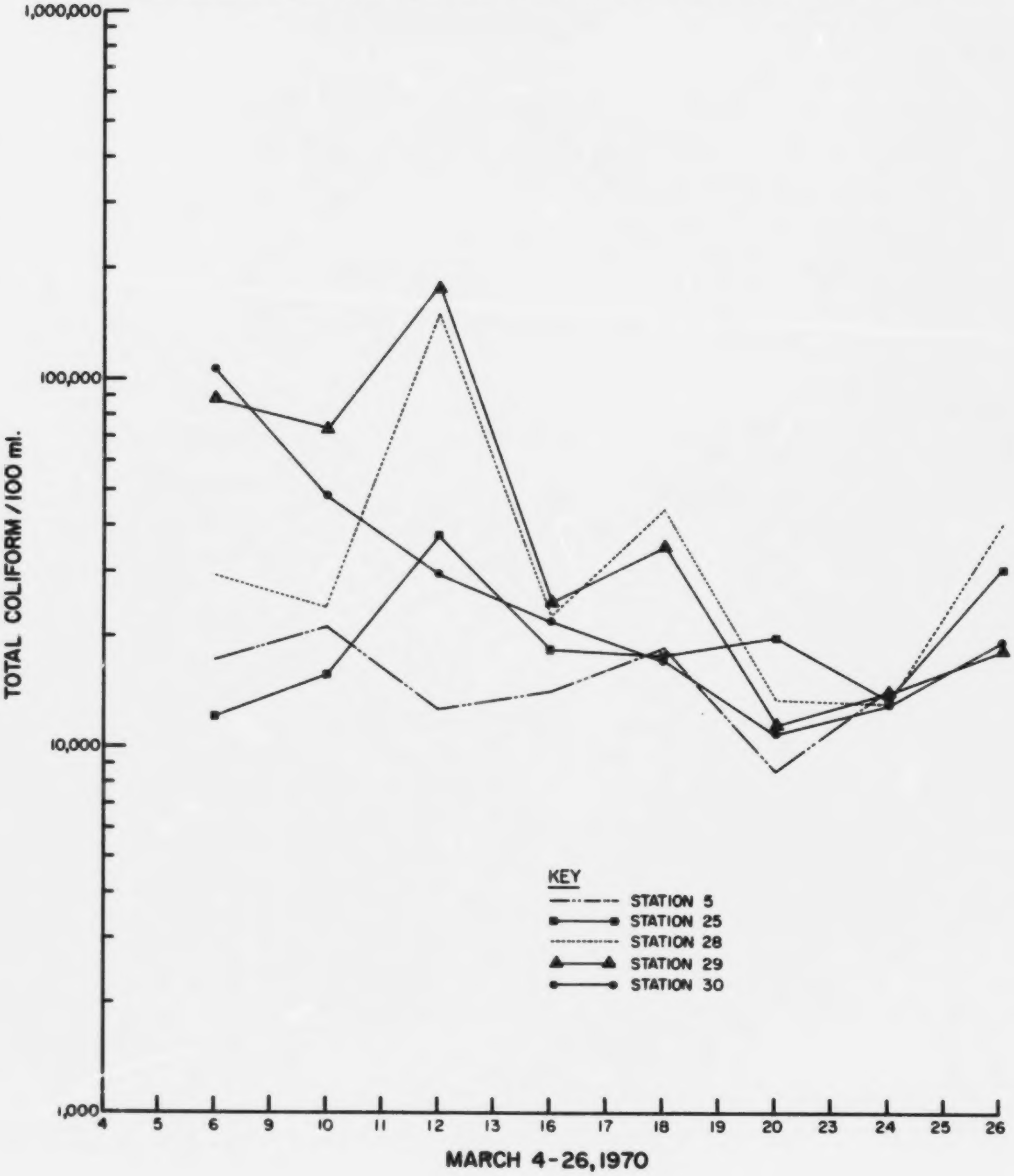


FIGURE C-3
DAILY TOTAL COLIFORM CONCENTRATIONS AT ALLIGATOR ALLEY STATIONS



c-79

FIGURE C-4
DAILY TOTAL COLIFORM CONCENTRATIONS AT TAMIAMI TRAIL STATIONS



C-80

FIGURE C-5
DAILY TOTAL COLIFORM CONCENTRATIONS AT HIGHWAY 29 & 840-A CANAL STATIONS

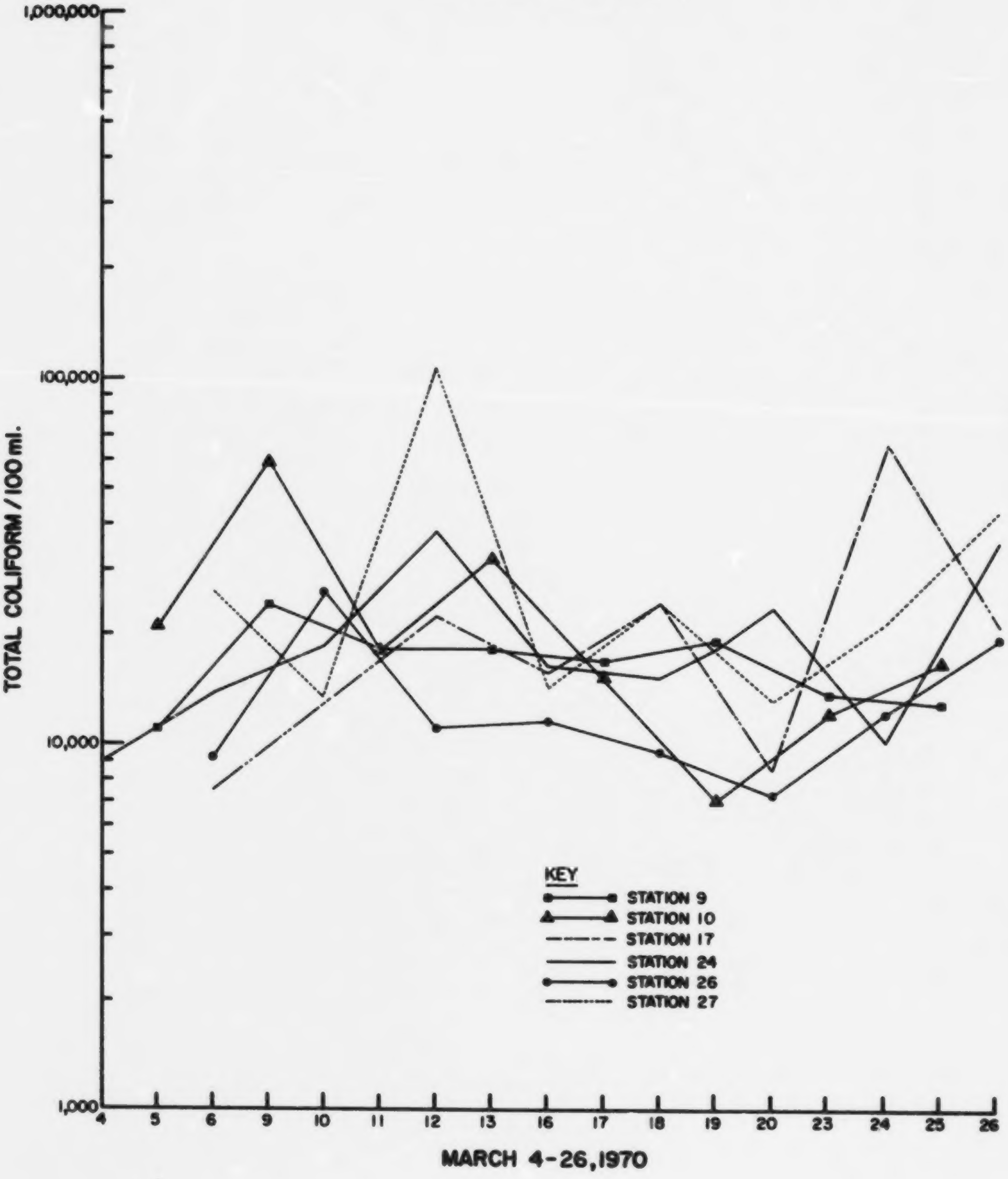
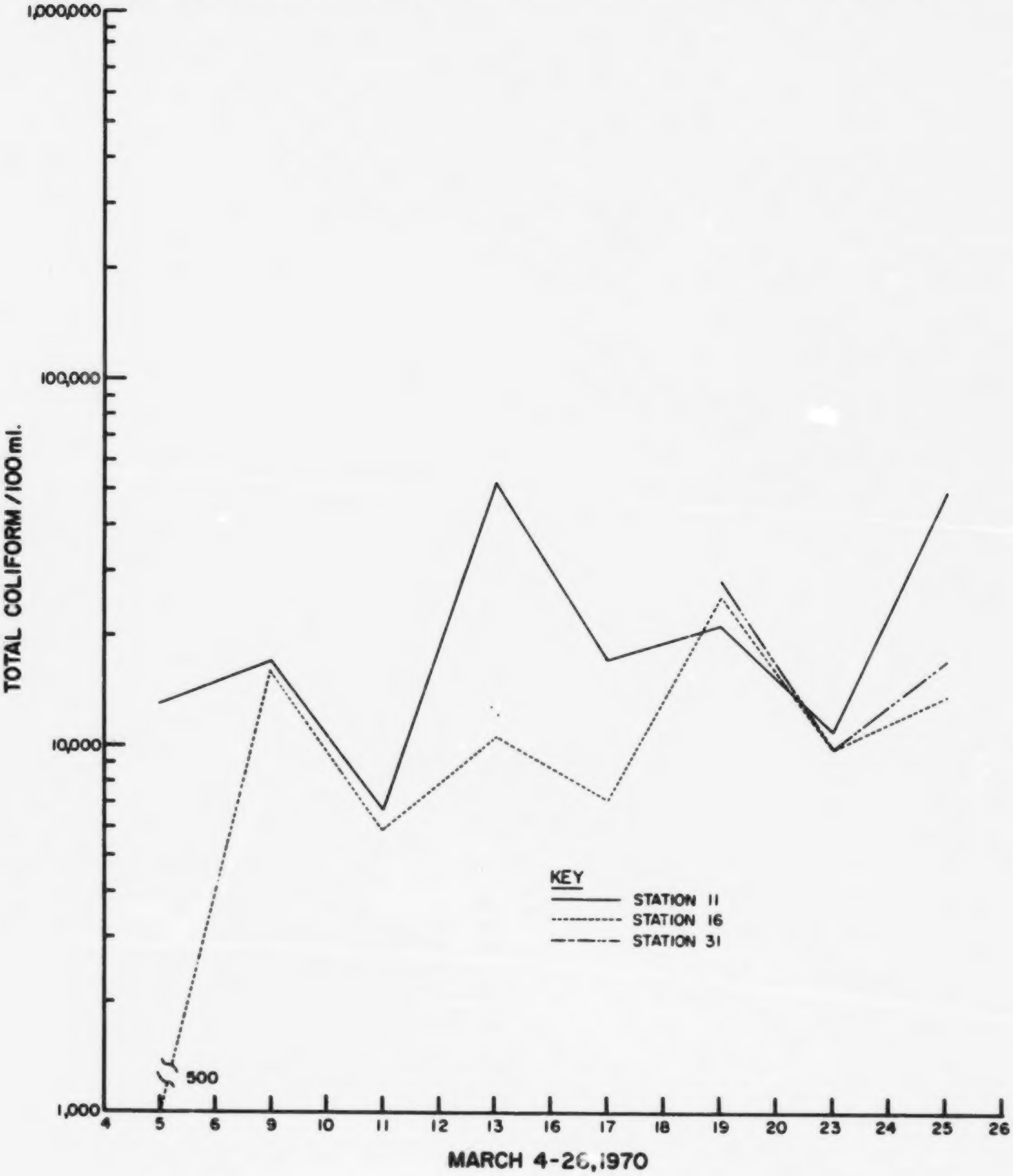
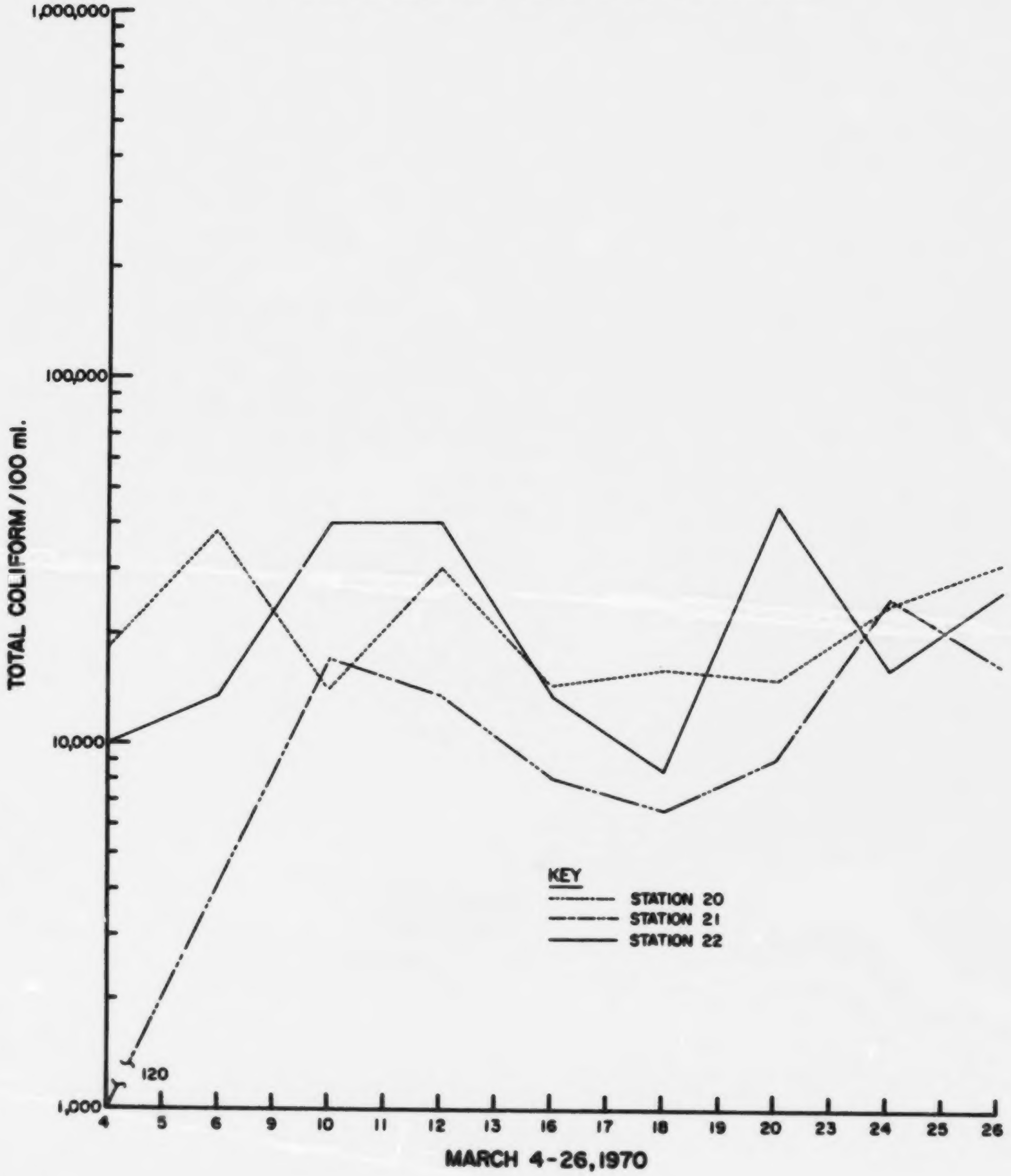


FIGURE C-6
DAILY TOTAL COLIFORM CONCENTRATIONS AT THE UPPER
OKALOACOOCHEE SLOUGH & L-28 INTERCEPTOR CANAL STATIONS



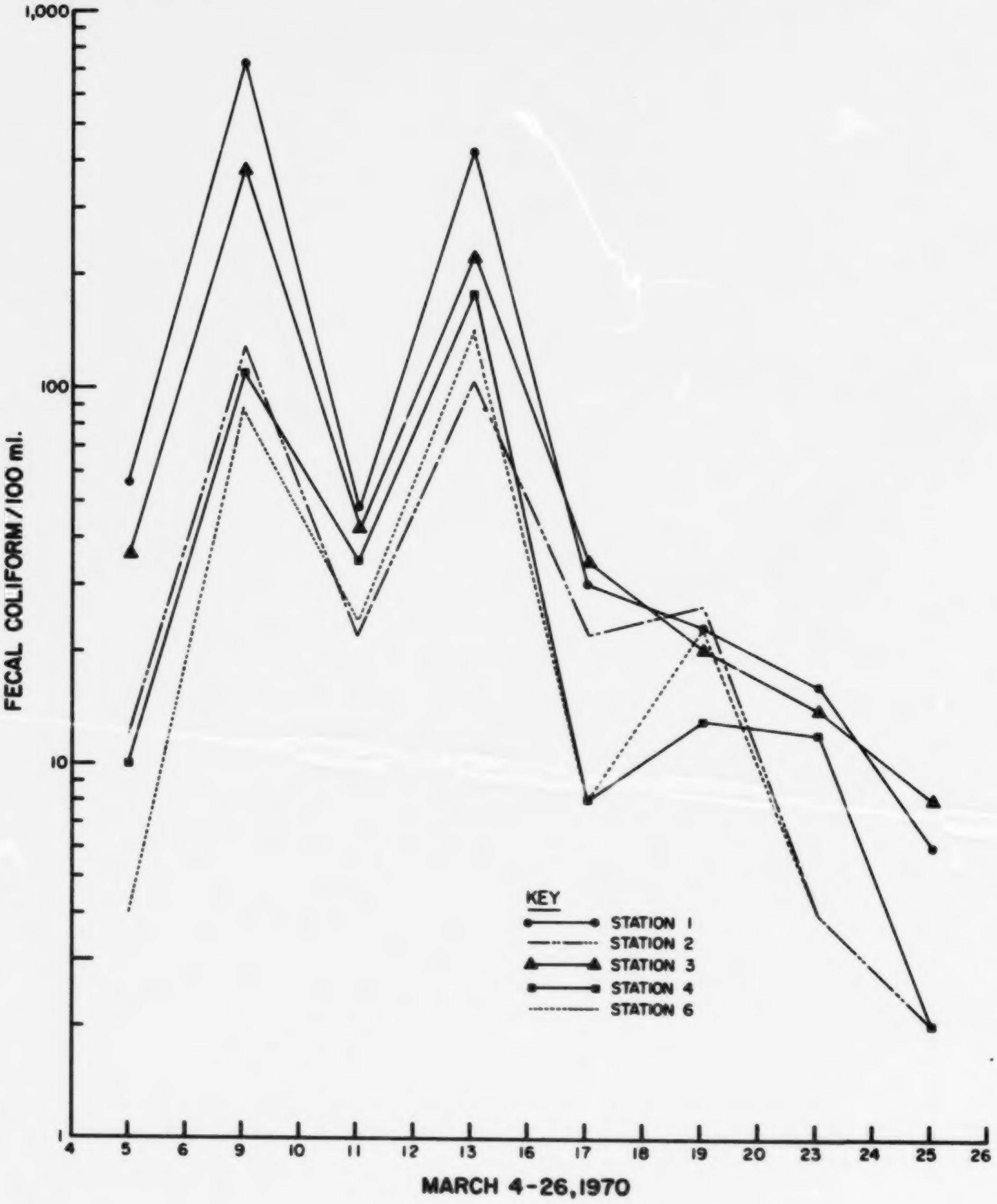
C-82

FIGURE C-7
DAILY TOTAL COLIFORM CONCENTRATIONS AT THE FAKAHATCHEE STRAND (JANES SCENIC DRIVE) STATIONS



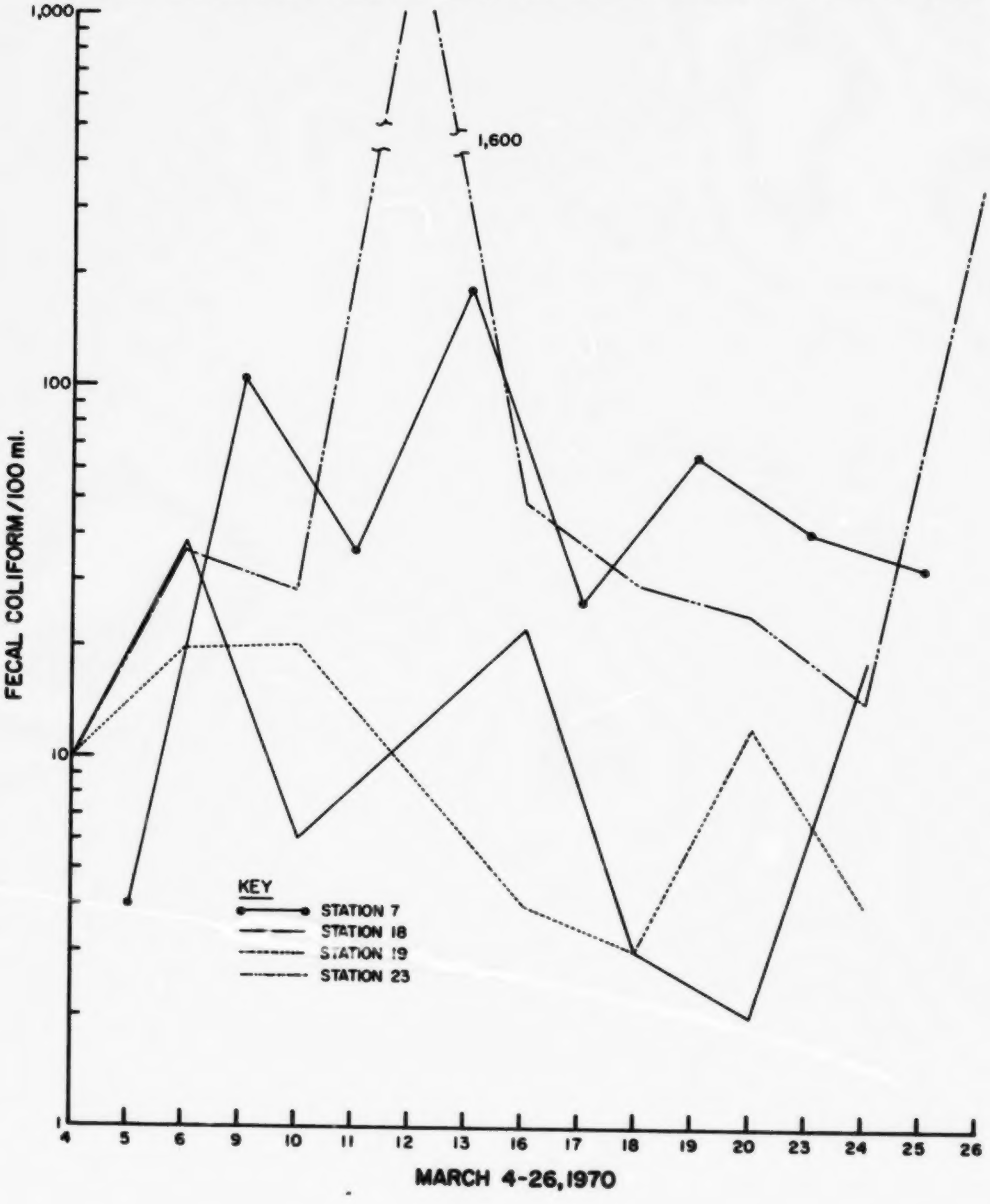
C-83

FIGURE C-8
DAILY FECAL COLIFORM CONCENTRATIONS AT G.A.C. CANAL STATIONS



C-84

FIGURE C-9
DAILY FECAL COLIFORM CONCENTRATIONS AT G.A.C. CANAL STATIONS



. C-85

FIGURE C-10
DAILY FECAL COLIFORM CONCENTRATION AT ALLIGATOR ALLEY STATIONS

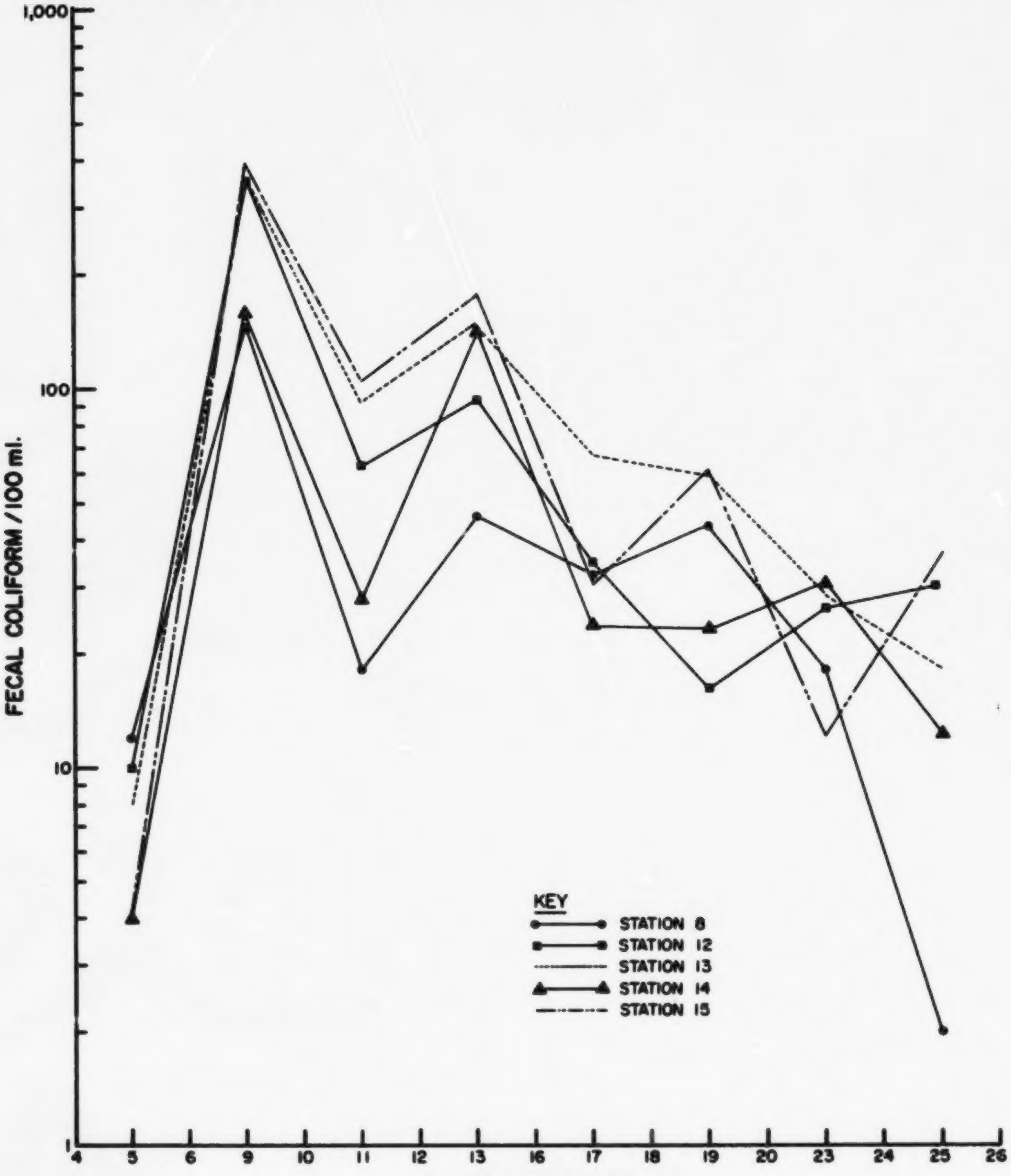
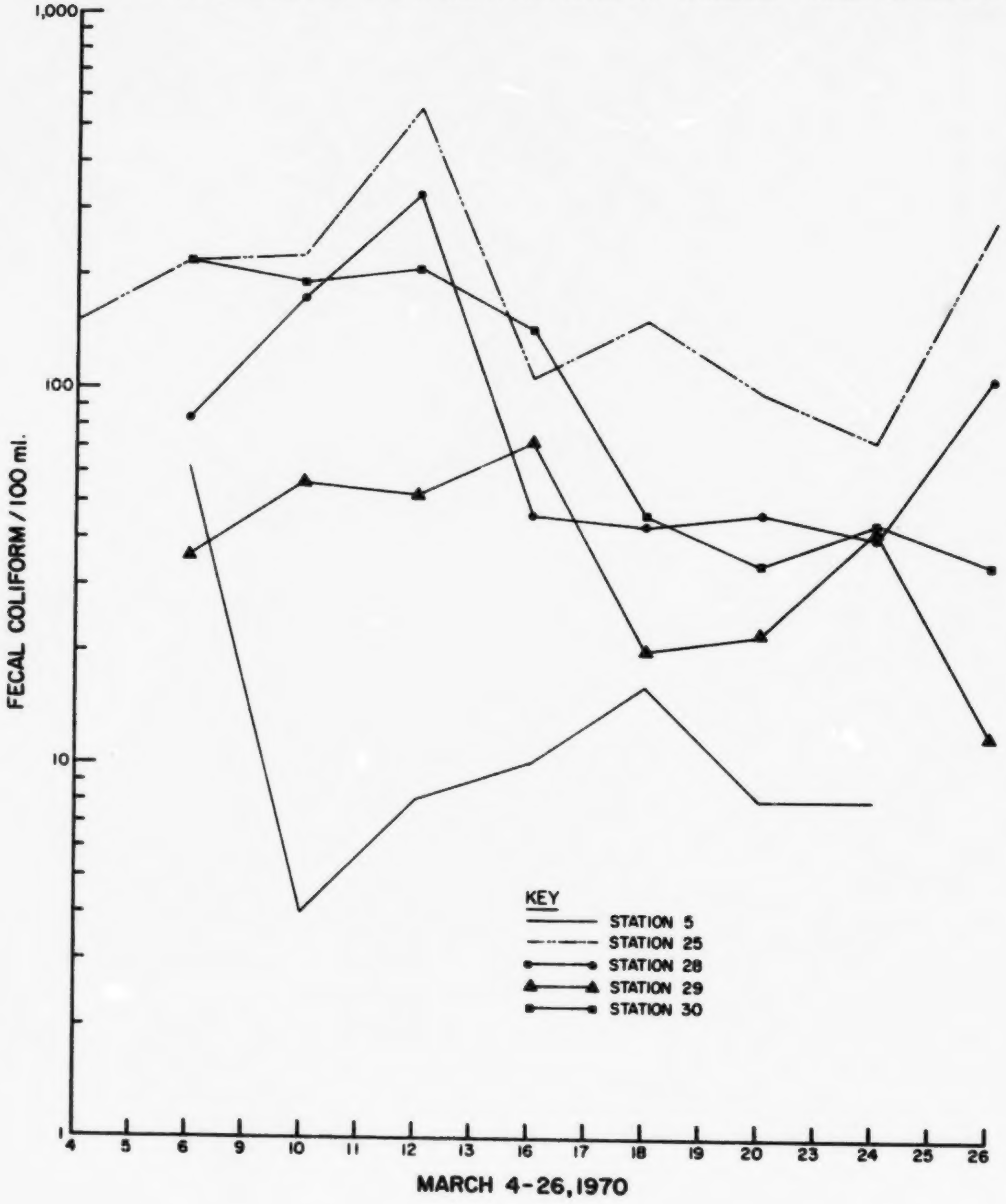


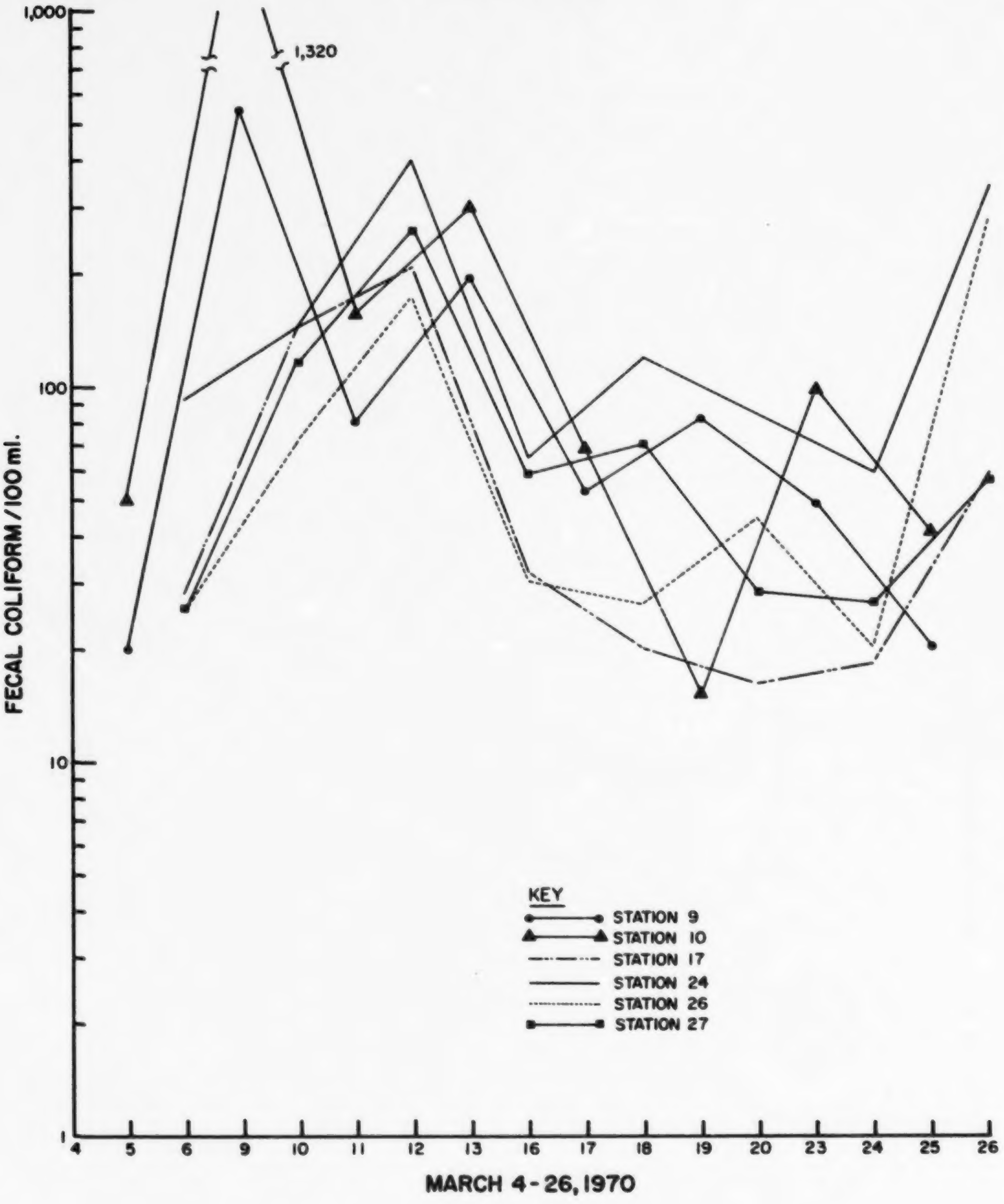
FIGURE C-11

DAILY FECAL COLIFORM CONCENTRATIONS AT TAMIAMI TRAIL STATIONS



C-88

FIGURE C-12
DAILY FECAL COLIFORM CONCENTRATIONS AT HIGHWAY 29 & 840-A CANAL STATIONS



1

C-89

FIGURE C-13
DAILY FECAL COLIFORM CONCENTRATIONS AT THE UPPER OKALOACOOCHEE SLOUGH & L-28 INTERCEPTOR CANAL STATIONS

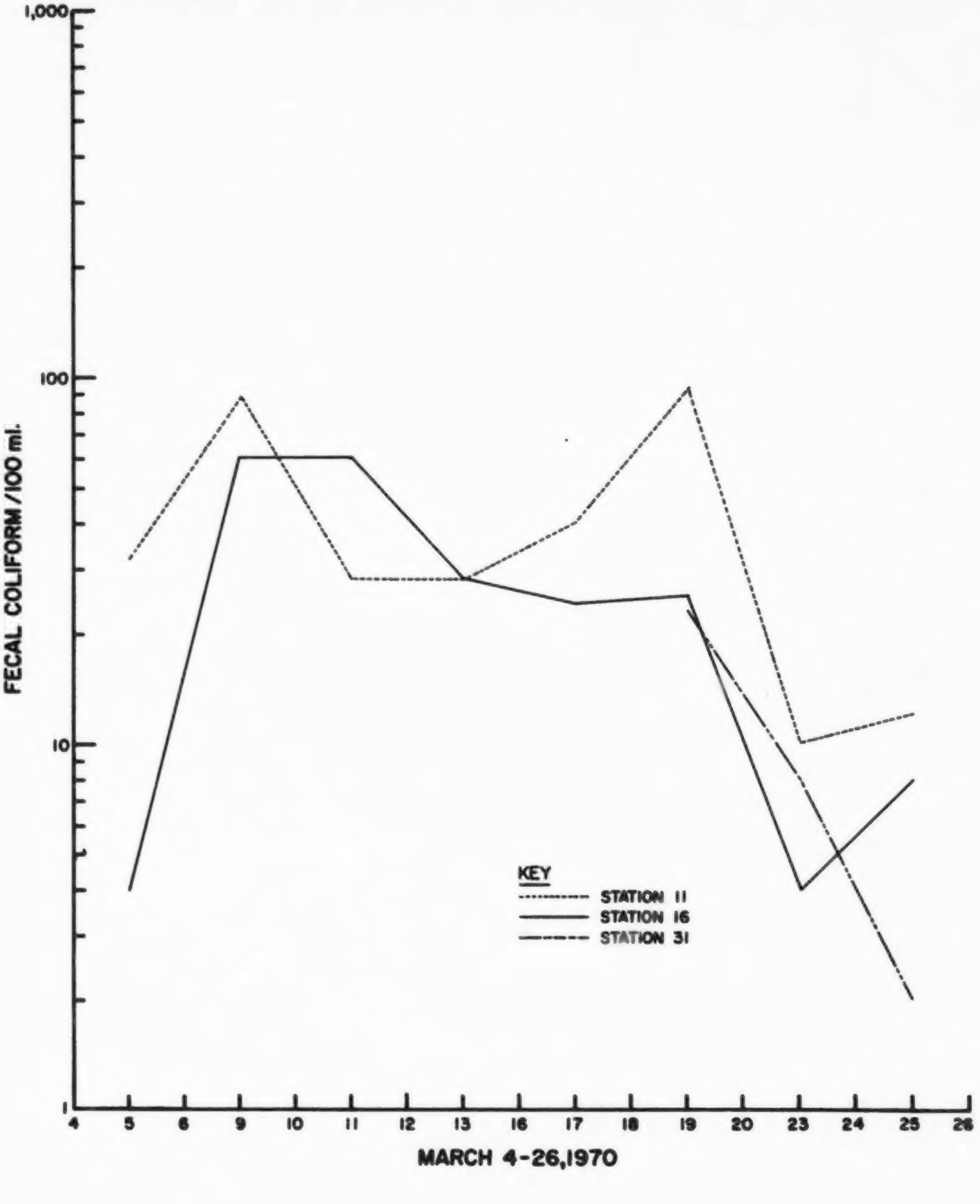


FIGURE C-14
DAILY FECAL COLIFORM CONCENTRATIONS AT THE FAKAHATCHEE STRAND (JANES SCENIC DRIVE) STATIONS

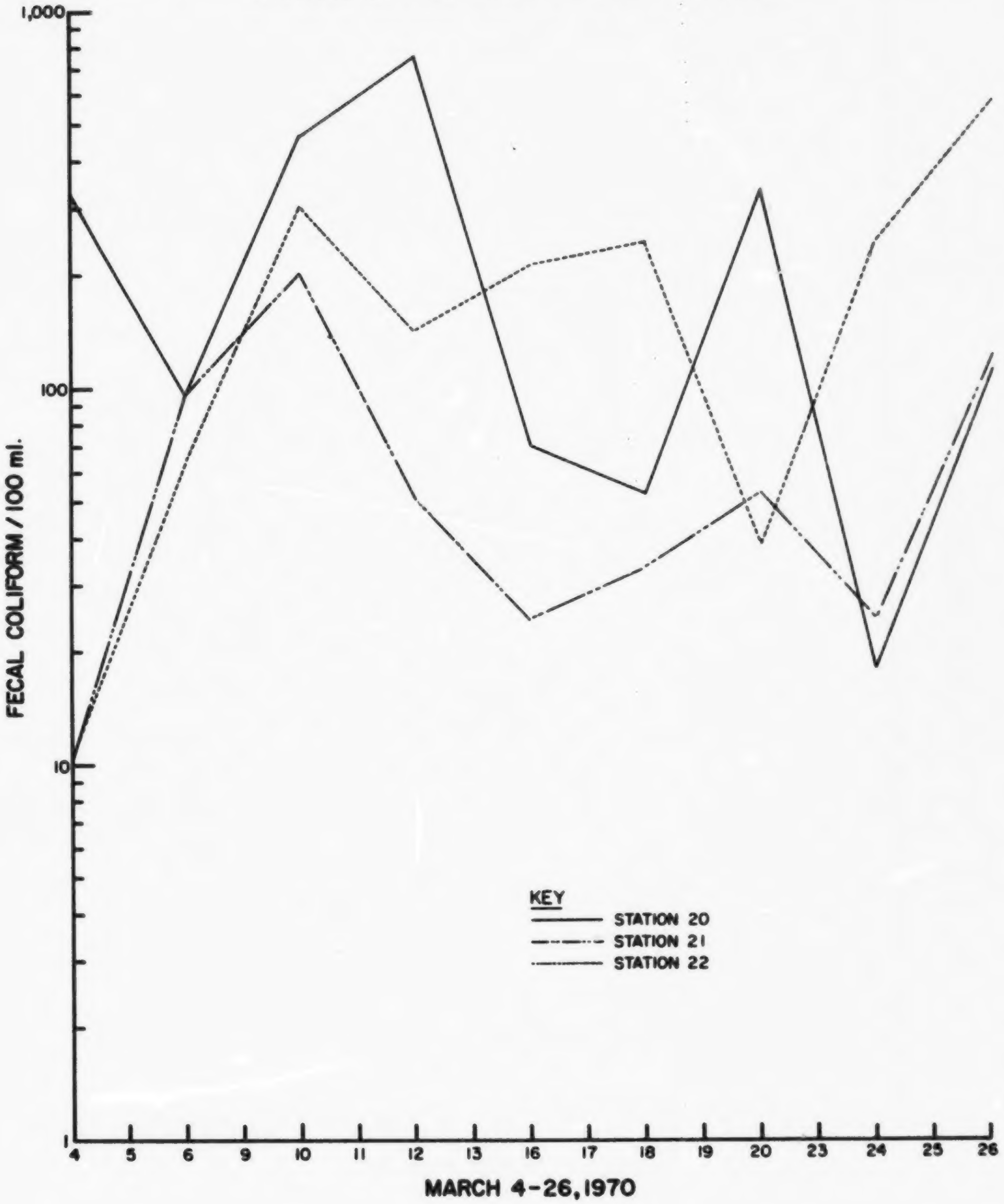


FIGURE C-15
DAILY TOTAL PLATE COUNTS AT G.A.C. CANAL STATIONS

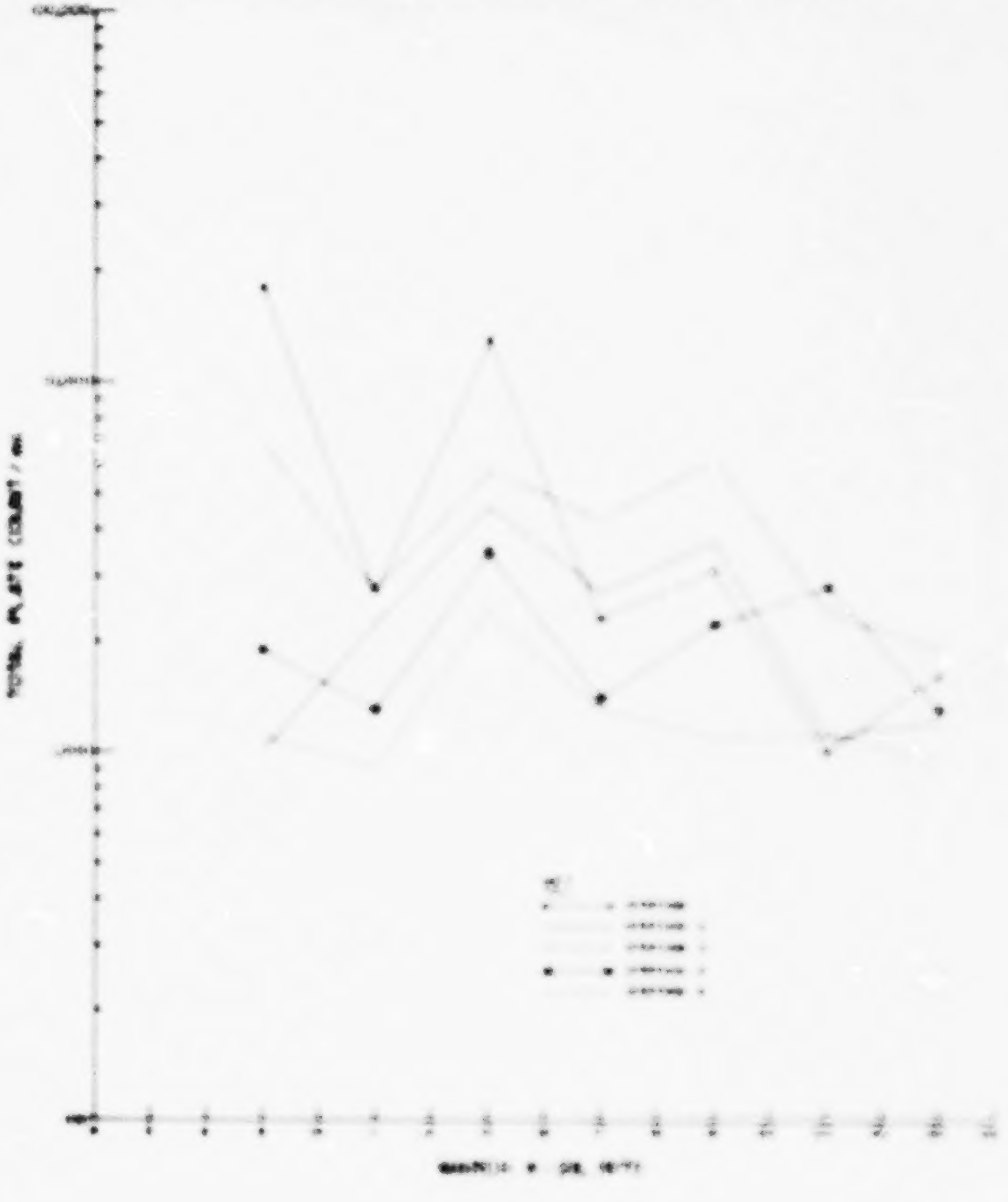


FIGURE C-16
DAILY TOTAL PLATE COUNTS AT G.A.C. CANAL STATIONS

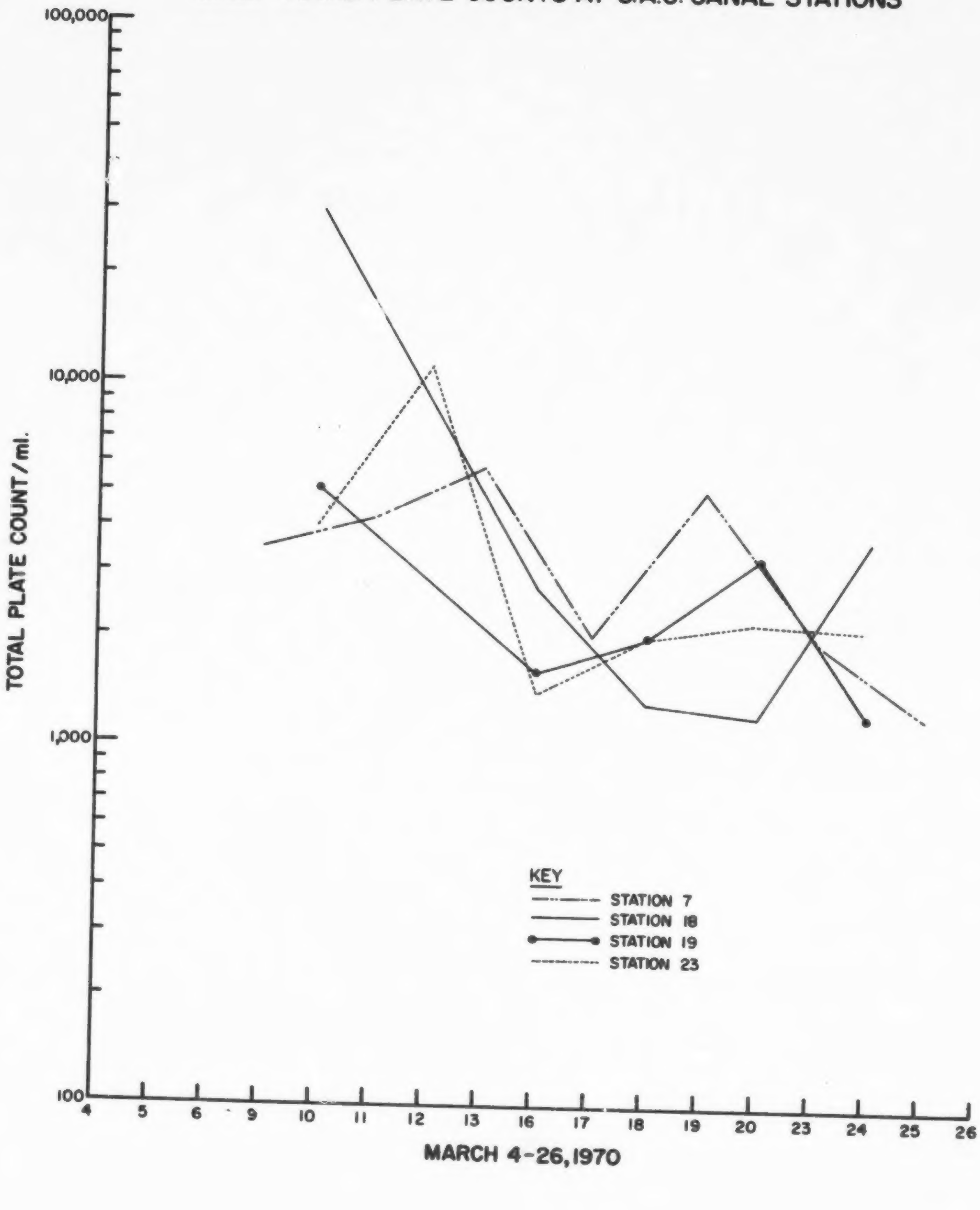
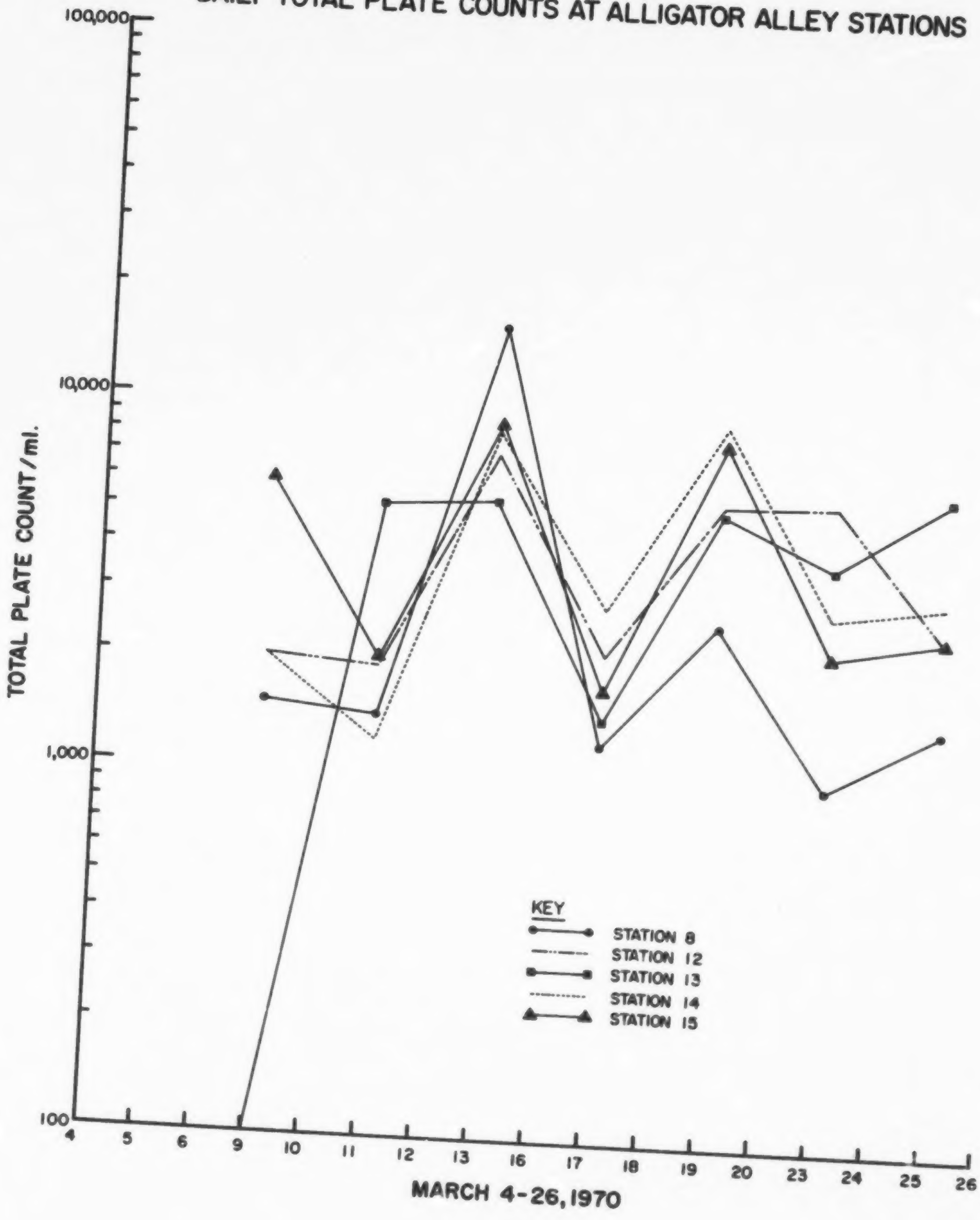


FIGURE C-17
DAILY TOTAL PLATE COUNTS AT ALLIGATOR ALLEY STATIONS



c-94

FIGURE C-18
DAILY TOTAL PLATE COUNTS AT TAMIAMI TRAIL STATIONS

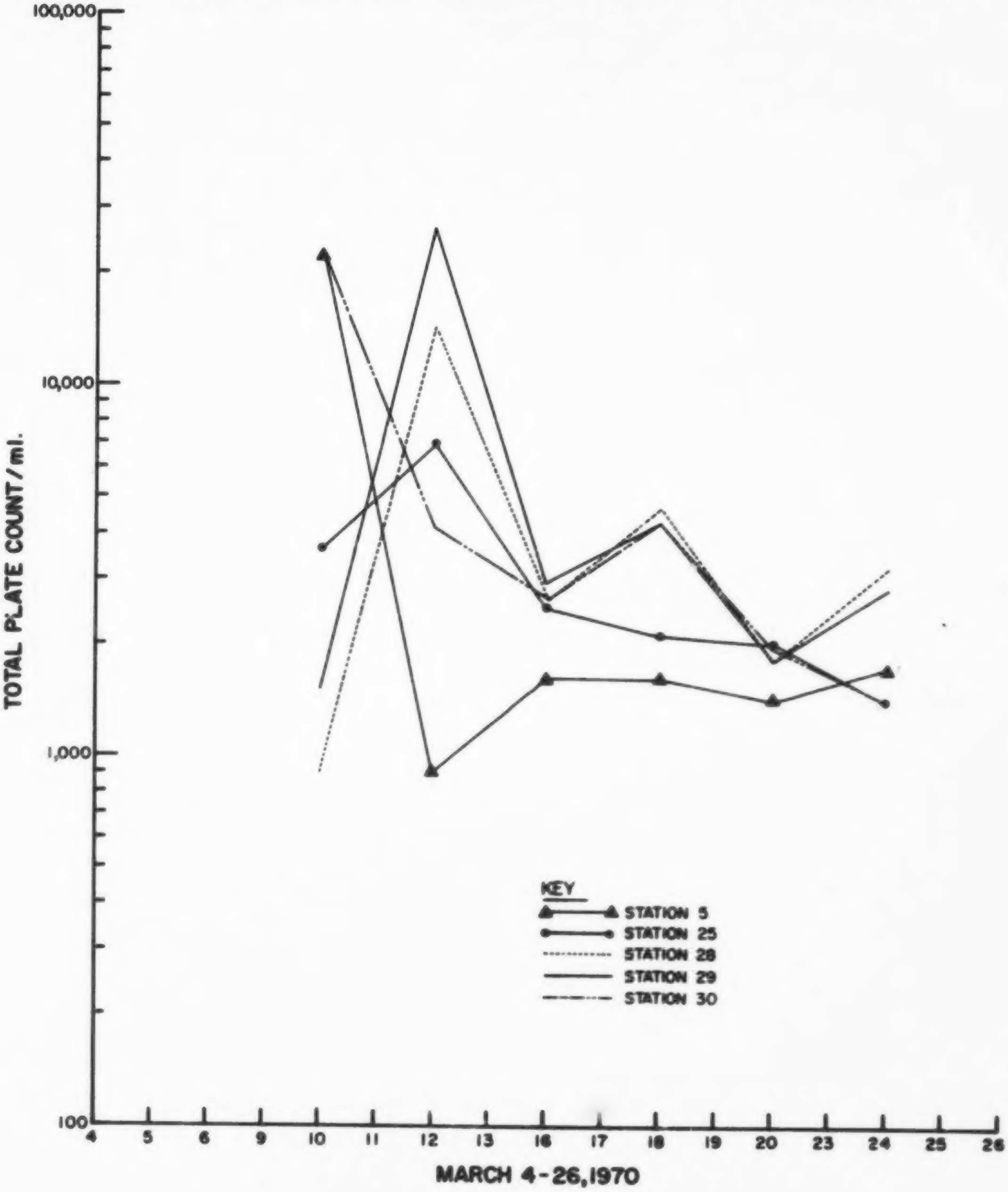


FIGURE C-19
DAILY TOTAL PLATE COUNTS AT HIGHWAY 29 & 840-A CANAL STATIONS

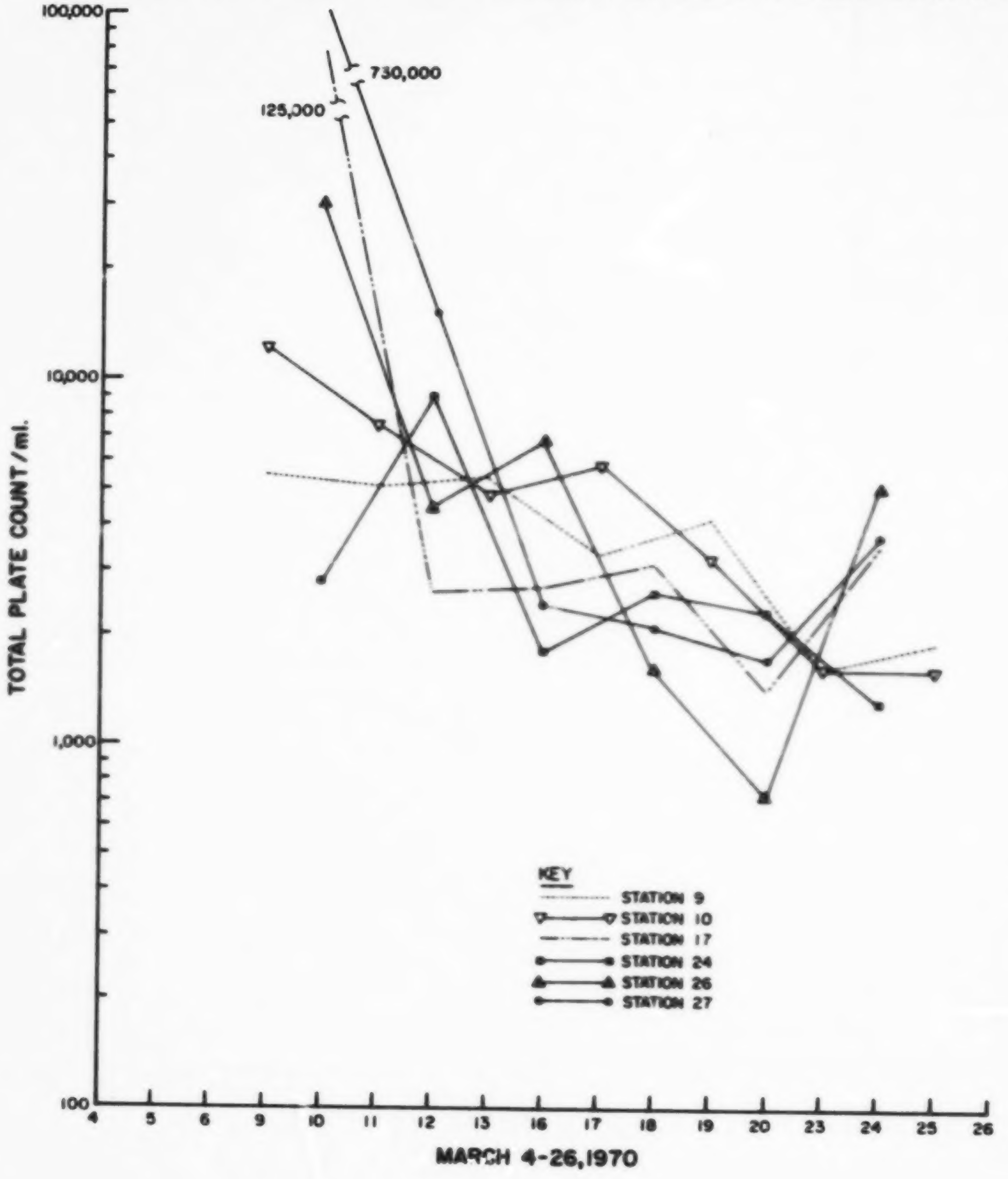


FIGURE C-20
DAILY TOTAL PLATE COUNTS AT THE UPPER
OKALOACOOCHEE SLOUGH & L-28 INTERCEPTOR CANAL STATIONS

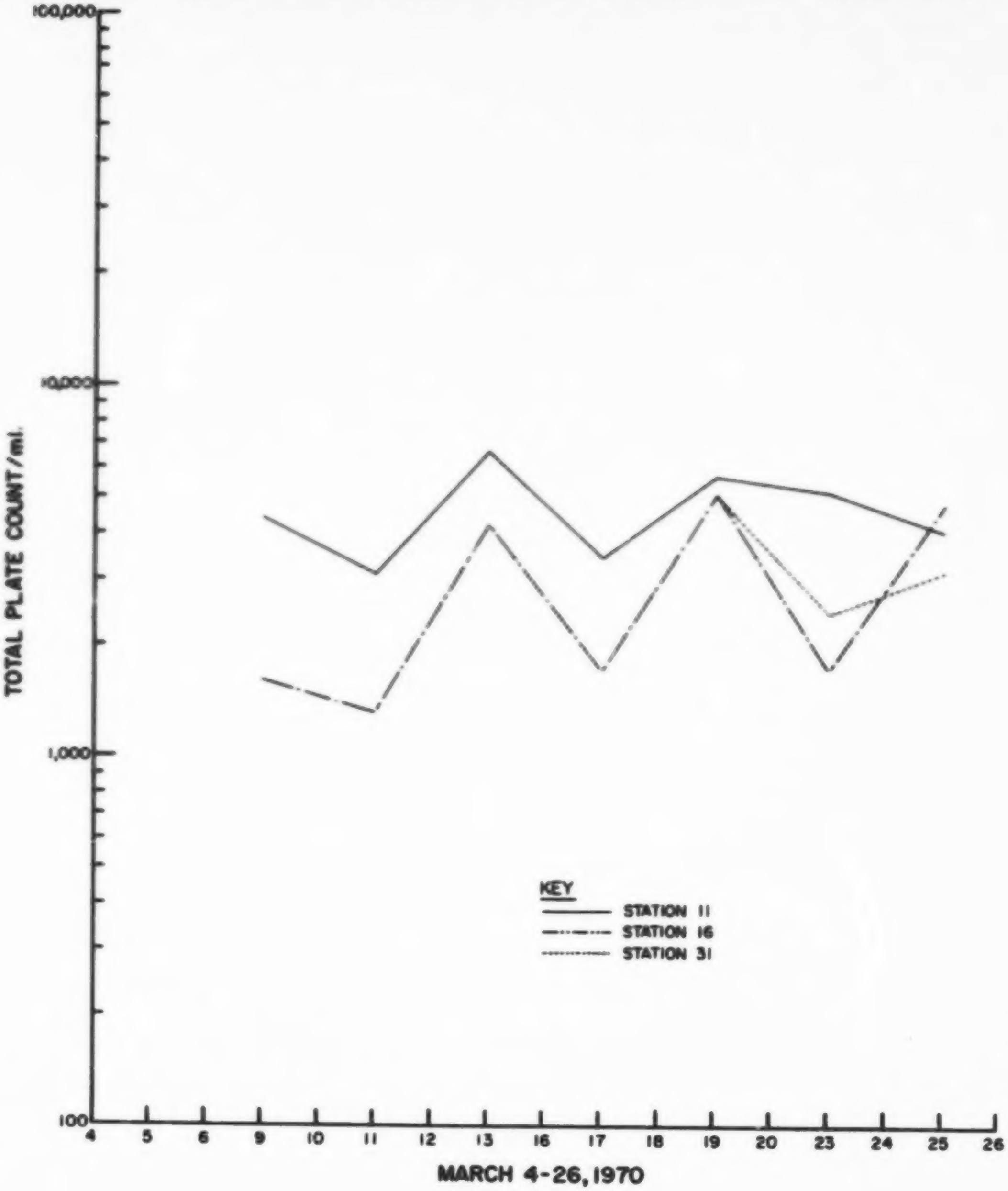


FIGURE C-21
DAILY TOTAL PLATE COUNTS AT FAKAHATCHEE STRAND
(JANES SCENIC DRIVE) STATIONS

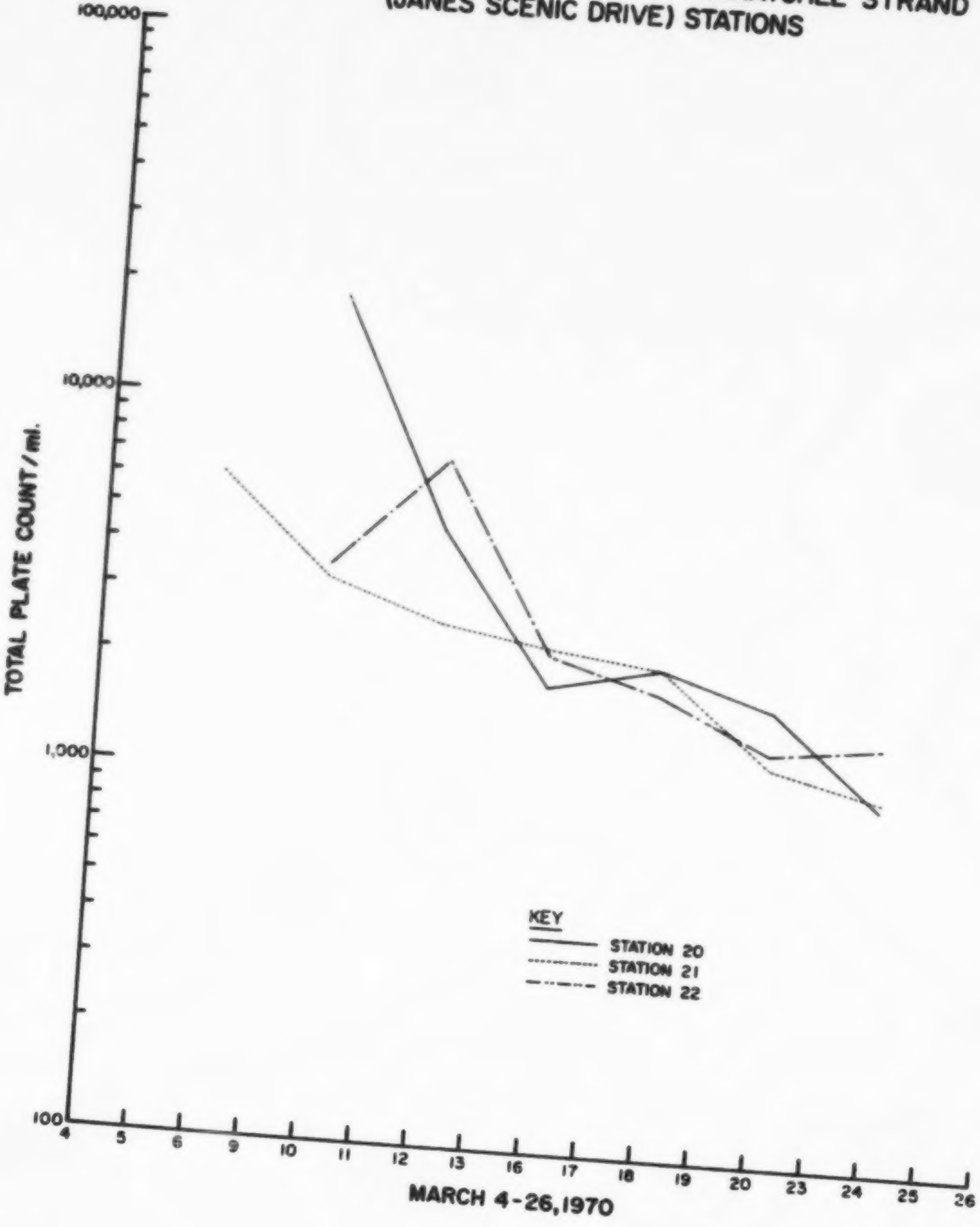


TABLE D-I

HOURLY VARIATION STUDY DATA

STATION	DATE (March) 1970	TIME	DISSOLVED OXYGEN mg/1	CARBON DIOXIDE mg/1	pH	TEMPERATURE °C
2	19	0900	1.3	47.8	6.7	22.5
		1050	2.3	49.4	6.7	23.5
		1215	2.1	49.0	6.7	24.0
		1400	1.9	54.6	6.9	24.2
3	19	0945	1.9	34.0	6.8	23.5
		1120	2.2	31.8	6.8	24.2
		1240	2.4	39.4	6.9	24.0
		1440	2.6	32.4	7.0	25.0
4	19	1020	0.3	55.6	6.8	23.5
		1140	0.3	59.2	6.7	24.0
		1315	0.8	60.8	6.8	24.0
		1500	1.0	--	6.9	24.5
12	20	0900	2.9	6.7	6.9	23.0
		1010	3.0	6.9	6.9	24.0
		1200	3.0	7.3	7.2	24.0
		1415	3.8	7.1	7.2	25.5
		1600	5.2	5.7	7.2	26.0
13	20	0920	5.9	3.2	7.3	24.5
		1030	6.2	2.1	7.3	25.0
		1230	6.2	0.9	7.3	26.0
		1435	6.3	3.9	7.3	26.5
		1630	6.8	2.1	7.5	27.5
14	20	0940	5.9	3.6	7.3	24.5
		1045	6.0	3.3	7.3	25.0
		1245	6.2	2.4	7.3	26.0
		1450	6.1	3.4	7.5	26.5
		1645	6.6	2.6	7.5	27.5
20	24	0900	5.1	2.4	7.3	17.0
		1030	6.3	1.6	7.5	18.0
		1200	7.2	0.8	7.4	19.5
		1400	8.2	0	7.6	21.5
		1600	8.0	0	7.6	22.0
21	24	1000	4.7	4.4	7.3	17.5
		1130	5.8	2.4	7.5	19.0
		1250	7.0	1.4	7.5	19.5
		1450	8.4	0.6	7.8	21.0
		1650	8.4	0.6	7.8	21.5

HOURLY VARIATION STUDY DATA (CONT'D)

STATION	DATE (March) 1970	TIME	DISSOLVED OXYGEN mg/1	CARBON DIOXIDE mg/1	pH	TEMPERATURE °C
22	24	0925	3.3	5.2	7.3	17.5
		1100	3.2	5.3	7.4	17.5
		1220	4.5	5.8	7.5	18.0
		1420	6.8	2.7	7.5	20.0
		1620	6.9	1.7	7.5	20.0
28	23	0830	2.7	6.3	7.0	22.0
		1000	3.3	6.6	7.1	22.0
		1200	4.2	5.4	7.3	22.5
		1400	4.8	3.5	7.3	23.0
		1600	6.1	0	7.4	24.0
29	23	0900	2.4	5.4	7.0	22.7
		1025	3.0	4.0	7.1	23.0
		1230	4.1	2.7	7.2	23.0
		1430	6.1	1.4	7.3	25.0
		1630	6.6	0	7.4	25.5
30	23	0920	3.3	3.8	7.1	21.5
		1040	4.4	2.4	7.2	21.5
		1245	6.3	1.8	7.5	22.0
		1445	7.6	0	7.5	24.5
		1645	7.9	0	7.6	25.2

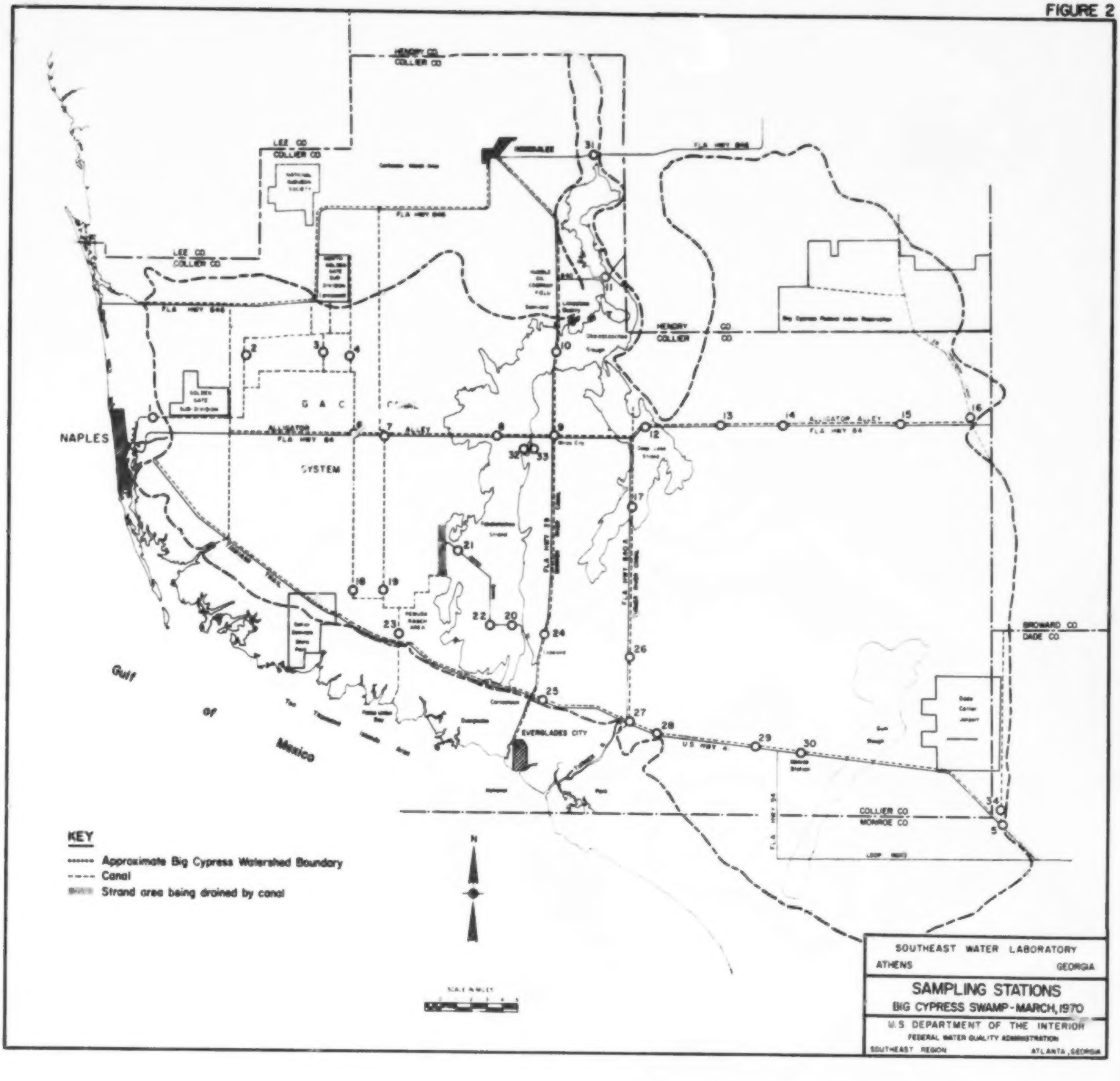
D-3

PARTICIPATING STAFF

Tom B. Bennett	Chemist
Ruby N. Bowden	Stenographer
Nan Cain	Secretary
Bobby J. Carroll	Microbiologist
N. Elayne P. Cook	Stenographer
Sylvia M. Dawson	Clerk-typist
James H. Finger	Chief Chemist
Paul J. Frey	Aquatic Biologist
Ralph E. Gentry	Microbiologist
Ray N. Hemphill	Chemist
John A. Little	Sanitary Engineer
William E. Loy	Chemist
Carolyn S. Miller	Technician
Charles T. Poland	Technician
Carolyn M. Pope	Technician
Lavon Revells	Chemist
Robert F. Schneider	Aquatic Biologist
Donald Schultz	Aquatic Biologist
David R. Smith	Aquatic Biologist
Myron Stephenson	Technician
Trudy C. Stiber	Stenographer
Hugh C. Vick	Technician
M. Ronald Weldon	Technician
Roy A. Whatley	Engineer
Roy A. Wiemert	Technician
Raymond T. Wilkerson	Technician

D-4

FIGURE 2


HENDRY CO
COLLIER CO
LEE CO
COLLIER CO
IMMOKALEE
FLA HWY 846
FLA HWY 858
LEE CO
COLLIER CO
HENDRY
COLLIER
CO
CO
NAPLES
G A C
SYSTEM
ALLIGATOR ALLEY
FLA HWY 84
FLA HWY 29
FLA HWY 839
TAMIAMI TRAIL
US HWY 41
EVERGLADES CITY
BROWARD CO
DADE CO
COLLIER CO
MONROE CO
LOOP ROAD
FLA HWY 94
Gulf
of
Mexico
The Ten Thousand Islands Area
N
SCALE IN MILES
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
KEY
Approximate Big Cypress Watershed Boundary
Canal
Strand area being drained by canal

SOUTHEAST WATER LABORATORY
ATHENS GEORGIA

SAMPLING STATIONS
BIG CYPRESS SWAMP - MARCH, 1970

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER QUALITY ADMINISTRATION
SOUTHEAST REGION ATLANTA, GEORGIA